

A DICTIONARY OF ELECTRICAL TERMS

INCLUDING TELEGRAPHY, TELEPHONY
AND WIRELESS

BY

S. R. ROGET

M.A. (CANTAB.), A.M. INST. C.E., A.M. I.E.E.



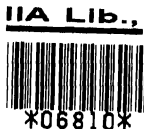
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PREFACE

IN the compilation of this collection of expressions in common use in the science and applications of electricity and magnetism, the endeavour has been made to steer a middle course between incompleteness and a redundancy which would defeat the objects of the work by inconvenient bulk and clumsiness in use. The subject-matter has therefore been kept within the electrical side of the boundary, even where it interlocks considerably with neighbouring branches of science or practice. Thus the central station engineer will find matter relating only to the electrical portion of his power house, while the steam side is unrepresented. Purely mechanical features of electrical machinery are not included, although considerable detail is gone into as to names of different parts of more electrical nature.

The borderlands of such highly specialized fields as the modern developments of electrochemistry and electro-medical work, which concern the chemist and the physiologist rather than the electrician, have not been entered to any depth. Similarly, only the strictly electrical side of railway engineering and other applications of electrical energy have been dealt with. Thus many special terms in railway signalling not inherently electrical have been left out and the purely "traffie" side of telephony and telegraphy is not dealt with. On the other hand, in the case of general physical units, light and heat, a greater latitude has been observed. Considerable space has been saved by omission of obvious combinations, the avoidance of needless repetition of cognate forms, and the liberal use of italics to invite reference to other entries.

As a rule, purely trade names of apparatus have been left alone, except in some cases where they are so intimately associated with apparatus as to amount practically to technical terms, or where it has been deemed desirable to point out a distinction between a trade name and one

that is truly descriptive, in order to avoid a misconception. Similarly, one or two apparently electrical popular terms have been included with the explanation that they are not really connected with electrical matters.

The range covered embraces electric light, power, and traction; telegraphy and telephony, including "wireless," and other miscellaneous applications, in some detail, as well as the general science of electricity and magnetism, without proceeding too far into its ramifications in the directions of pure physics and chemistry, etc., in one direction nor with the commercial side of industries dependent upon electrical methods in the other.

It has been found impossible to make any hard and fast distinction as to Americanisms. Many terms are almost entirely confined to the United States, and there are more which originated there and are now in equally common use on both sides of the Atlantic. In order, therefore, that the work shall be of use to the English reader of American technical literature, as well as to the American reading English works, explanations are given of both classes of expressions without any attempt to classify them. The explanations, however, employ consistently the terminology usual in this country.

It should be made clear that there has been no intention of competing with officially established definitions, such as the excellent series compiled by the British Standards Institution and by the International Electro-technical Commission. As far as practicable, however, the nomenclature adopted has been brought in line with that recommended by these bodies. The author's purpose has been to give explanations rather than definitions, and he has endeavoured to cover a rather wider field. He has taken expressions as they are found in the branches of technical and scientific literature in question and essayed to indicate what was meant by their use; but it has been no part of his work to establish limits to the meaning of a word or to standardize the expressions to be used to express a certain meaning. A great need exists, however, for such official limitation. There is in technical literature too much looseness and diversity of expression. A growing class of writer delights in inventing new terms, and there

is considerable tendency for workers in different fields to appropriate the same terms and to give them different meanings with resulting confusion to the non-specialist. It is not, however, the present object to criticize or to standardize, but rather to take the terms as they stand and to try to put the reader on the road towards their understanding.

Conciseness has been kept in view throughout, although not, it is hoped, at the sacrifice of intelligibility, and no attempt has been made to trespass on the functions of the textbook. It will be noticed in comparing different explanations that the standard of knowledge assumed on the part of the reader is somewhat variable. This is because it is felt that the more highly specialized is the significance of a term, the greater will be the experience of the reader likely to be brought in contact with it.

The author desires gratefully to acknowledge many kind suggestions made during the preparation of the first edition of the work by Dr. Alexander Russell, F.R.S. In subsequent editions several thousand further expressions have been added, and many alterations have been made in the interests of accuracy, clearness, and completeness.

S. R. R.



DICTIONARY OF ELECTRICAL TERMS

[The printing of a word in *italics* is an invitation to refer to that heading for further information.]

A]

A

[Abs

A. Abbreviation for *Ampere*: symbol for *Work*.

Å. Abbreviation for Ångström Unit.

"A" Battery. The low voltage battery used for the filament circuits of *Thermionic Valves*. Cf. "B" BATTERY and "C" BATTERY.

A.B.C. Telegraph (Wheatstone). A step-by-step dial system of telegraphy, in which a separate key is used for each letter, and the needle of the receiving dial stops at the letter to be indicated, after having been fed forward by the correct number of current impulses.

Abampere, Abcoulomb, Abfarad, Abohm, Abvolt, etc. Proposed names for the absolute C.G.S. electro-magnetic units of current, quantity, capacitance, resistance, e.m.f., etc. Cf. ASTATAMPERE, etc.

Abnormally Polarised Waves. Electric waves (as used in wireless telegraphy, etc.), in which the magnetic component is not at right angles to the plane of propagation, e.g. the waves (present more particularly at night) reflected or refracted from the *Ionosphere*. Cf. NORMALLY POLARISED WAVES.

Absolute Determination. A determination of a physical quantity, made directly from the fundamental standards of length, mass, and time, without comparison with any previously calibrated standard of its own kind.

Absolute Electrometer. An instrument for determining electric potential by weighing the attraction of a charged disc against gravity.

Absolute Galvanometer. A galvanometer by which an *Absolute*

Determination of a current can be made, as its *Constant* can be deduced from known data.

Absolute Measurements. See ABSOLUTE DETERMINATION.

Absolute Potential. See POTENTIAL.

Absolute Units. Units derived from the fundamental units of length, mass, and time. In the case of electrical units, two such systems of units have been derived from the centimetre, the gramme, and the second, depending respectively upon electrostatic and electro-magnetic relations. See C.G.S. UNITS. The practical units, the *Ampere*, the *Volt*, etc., are convenient multiples or submultiples of the latter.

Absorber (in wireless telegraphy, etc.). A device for absorbing the energy normally put into the aerial of a transmitter in a non-radiating circuit for testing purposes.

Absorber, Harmonic. See HARMONIC ABSORBER.

Absorber Valve (in Wireless Telegraphy, etc.). A *Thermionic Valve* in a circuit controlled by the signalling key, which absorbs a part of the energy of the system during spacing periods.

Absorption (of electric waves). Causes of reduction in amplitude of electric waves during transmission other than *Geometrical Attenuation*.

Absorption, Dielectric. See DIELECTRIC ABSORPTION.

Absorption Coefficient. (1) Of light. See ABSORPTION FACTOR. (2) Of X-rays. The ratio of the rate of change (with depth) of the *Intensity* of X-rays at a point in the

medium, to the intensity at that point.

Absorption Coil. An iron-cored inductor between the two parts of a six-phase circuit feeding a *mercury-vapour rectifier*, rendering it equivalent to two three-phase circuits in parallel.

Absorption Control. See **ABSORPTION MODULATOR**.

Absorption Current. See **ANOMALOUS CHARGING CURRENT**.

Absorption Factor. The ratio of the *Luminous Flux* (lumens) absorbed by a body to that incident upon it. Symbol: a .

Absorption Modulator. A *Modulation* apparatus for wireless transmitting stations in which the variable resistance of the microphone produces a variation of the radiation resistance of the aerial, either directly or through an intermediate valve circuit.

Absorption Wavemeter. An instrument for measuring wavelength of received waves by absorption in an oscillating circuit tuned to resonate with them. The fact of resonance can be indicated in a variety of ways.

Abstatampere, Abstatcoulomb, Abstatfarad, Abstatvolt, etc. Proposed names for the absolute C.G.S. electrostatic units of current, quantity, capacitance, v.m.f., etc. Cf. **ABAMPERE**, etc.

A.C. The usual abbreviation for *Alternating Current*.

"A" Cord Circuit. A subscriber's operator's *Cord Circuit* in a telephone exchange.

Accelerating Grid (in a *Cathode Ray Oscillograph*). A grid, charged at a moderate potential, placed in front of the screen to accelerate the electron stream and to increase its energy.

Acceleration, Automatic. See **AUTOMATIC ACCELERATION**.

Accelerator. An *Anode* in a *Cathode Ray Tube*, serving principally to accelerate the electrons forming the beam.

Accelerometer. An instrument for measuring acceleration. A direct reading electrical accelerometer may be made by a voltmeter coupled through a transformer to a

magneto generator, so that it will indicate the rate of change of the voltage produced and consequently of the speed at which the magneto is driven.

Acceptor Circuit. A circuit consisting of a combination of inductance and capacitance in series, permitting the passage of currents or oscillations of one frequency only. (Cf. **REJECTOR CIRCUIT**.) Used for avoiding interference in wireless reception.

Accumulator. An (electrical) accumulator, *Storage Battery* or *Secondary Battery*, is a group of *Secondary Cells*, in which the energy of a current can be stored chemically during charging and given out again electrically during discharge.

Accumulator: Alkaline, Anti-sulphating, Drumm, Edison, Faure, Halogen, Iodide, Jungner, Lead, Nickel-Cadmium, Nickel-Iron, Planté, and Zinc-Lead. See **ALKALINE ACCUMULATOR, ANTISULPHATING ACCUMULATOR**, etc.

Accumulator Battery. A battery of *Accumulator Cells*.

Accumulator Box. A vessel, usually of rectangular form, for containing the plates and electrolyte of an accumulator cell or several cells in separate compartments; made of glass, lead-lined wood, or celluloid, etc.

Accumulator Car. A railway, tramway, or road vehicle propelled electrically and deriving its energy from an *Accumulator Battery* carried thereon.

Accumulator Cell. A single *Cell* of an *Accumulator* or *Secondary Battery*.

Accumulator Container. See **ACCUMULATOR BOX**.

Accumulator Grid. The lead grid which holds the active material in the *paste* type of accumulator plate.

Accumulator Insulator. Glass or glass and oil insulator, upon which stand the individual cells of an accumulator battery to insulate them from the ground.

Accumulator Locomotive. A self-contained electric locomotive, deriving its energy from an accumulator battery carried thereon; used where contact rails or lines are

dangerous or inconvenient, as in mines, during constructive work, or for shunting operations.

Accumulator Switch. See BATTERY, REGULATING SWITCH.

Accumulator Switchboard. A switchboard equipped with all the necessary switchgear and instruments for controlling the charge and discharge of an accumulator.

Acetate Wire. Wire with an insulating covering of cellulose tetracetate.

Acheson Furnace. An electric furnace for the production of silicon carbide, in which the heating is obtained by the passage of a heavy current through a central core of coke surrounded by the material to be acted upon, consisting of coke and sand with the addition of salt as a flux and sawdust to render the composition porous.

Acidometer. A hydrometer for ascertaining the sp. gr. of the electrolyte in an accumulator cell, by which its condition and the degree of charge can be gauged.

Aclinic Line. A line on a magnetic map passing through the points of the earth's surface where the *Dip* or *Inclination* is zero, and forming what may be termed the *Magnetic Equator*. Cf. *ISOCLINIC* and *ISOAGONAL*.

Acoustic Sounding. See ECHO DEPTH SOUNDING.

Actinotherapy. The application of ultra-violet rays to curative purposes. See ARTIFICIAL SUNLIGHT.

Action, Local. See LOCAL ACTION.

Action Current. A term used in physiology for the brief and very small electric current in a nerve during a nervous impulse.

Active Component. See ACTIVE CURRENT and ACTIVE VOLTAGE.

Active Current. The component of an alternating current which is in phase with the voltage, and represents power in the circuit.

Active Electrode (in Electrical Precipitation). The electrode kept at a high potential. Also called the *Discharge Electrode*. Cf. *PASSIVE ELECTRODE*.

Active Material. The lead oxides or other substances in the plates of accumulator cells, the chemical

changes of which effect the storage and recovery of the energy of the charge.

Active Spark. A term sometimes used in wireless telegraphy for a pure spark which only contains the energy of the oscillating circuit and is not followed by any arcing effect. See QUENCHED SPARK and ARcing SPARK.

Active Voltage. The component of an alternating voltage which is in phase with the current.

Active Volt-Amperes. The product of the active volts and the current or of the volts and the active amperes, i.e. the watts.

Active Wires. An expression used in dynamo design for those parts of the armature conductors which actually cut the magnetic lines of force.

Acyelic Generator. See HOMOPOLAR GENERATOR.

Adapter. An appliance for connecting a piece of apparatus fitted with one system of terminals to another with different terminals.

Adapter: Plug, Short Wave, Socket Outlet, and Valve. See PLUG ADAPTER, SHORT WAVE ADAPTER, etc.

Adapter Transformer. A single lamp transformer arranged with its primary terminals to fit into an ordinary lamp holder and its secondary terminals in the form of a lamp holder to contain a low voltage lamp.

Adcock Direction Finder. A modification of the original closed loop direction finder employing spaced vertical aeriads.

Adhesion, Electrostatic and Magnetic. See ELECTROSTATIC ADHESION and MAGNETIC ADHESION.

Adhesive Tape. See INSULATING TAPE.

Adjustable Condenser. See VARIABLE CONDENSER.

Adjustable Speed Motor. See VARIABLE SPEED MOTOR.

Admiralty Unit (of Capacitance). See FAR.

Admittance. The reciprocal of *Impedance*. Symbol: *Y*.

Aerotropy, Magnetic. See MAGNETIC AEROTROPY.

Aerial. The system of conductors,

supported on high masts or otherwise, used for radiating and receiving electric waves in wireless transmitting and receiving stations. Usually connected to earth through the transmitter or receiver, except in the case of a *Frame Aerial*.

Aerial: Aperiodic, Anti-Fading, Anti-Static, Artificial, Balancing, Beveridge, Buried, Cage, Communal, Directive, Dumb, Dummy, Fan, Flat, Frame, Franklin, Ground, Half Wave-Length, Inverted "L," Loop, Multiple Tuned, Multi-Wire, Omni-, Phantom, Quarter Wave-Length, Sausage, Screened, Spaced, Submerged, "T," Umbrella, Unloaded, Untuned and Wave. See *APERIODIC AERIAL*, *ANTI-FADING AERIAL*, etc.

Aerial Array. An arrangement of wires more or less in the form of a flat screen or grid used in short wave beam transmitting stations.

Aerial Cable. Cable, usually un-insulated or lightly insulated, for *Aerial Lines*.

Aerial Circuit. All the apparatus and connections connected between the *aerial* and earth, including the aerial itself.

Aerial Conductor. Any wire or cable supported clear of the ground for the transmission of current.

Aerial Current. The r.m.s. value of the current in an aerial, at an antinode. Symbol: I_{as} .

Aerial Discharger. A path to earth for high-tension surges in a wireless aerial which does not interfere with the signals; sometimes a gas-filled tube.

Aerial Effect. Non-directional disturbance in a directional receiving apparatus due to unsymmetrical disposition of stray capacitance.

Aerial Earthing Switch. A switch provided for connecting the aerial directly to earth and disconnecting it from the receiving set when not in use.

Aerial Feed Impedance. The effective impedance of an *Aerial* as measured at a point to which a *Feeder* is connected.

Aerial Insulator. An insulator, usually of porcelain, for insulating an aerial from its supports.

Aerial Radiation Resistance. The component of the *Aerial Resist-*

ance due to the radiation of energy.

Symbol: R_r .

Aerial Resistance. A term used to include all effects having a result similar to true resistance in an aerial in wireless telegraphy, etc. Including the effect of radiation of energy. Symbol: R_{as} .

Aerial Switch. A switch for changing over the connections of the aerial in a wireless telegraph station, etc., from the arrangement required for transmitting to that required for receiving, and vice versa.

Aerial System. An *Aerial* and the whole of its supporting structure.

Aerial Tuning Condenser and Aerial Tuning Inductance. A variable condenser or inductance for tuning an aerial circuit to respond to a certain wave length.

Aether. See *ETHER*.

After Effect (in a Condenser). See *DIELECTRIC ABSORPTION*, *RESIDUAL CHARGE*, *ANOMALOUS DISCHARGE CURRENT*, etc.

Afterglow (in a Gas Discharge Tube). The persistence of luminosity in the tube or on the screen of a *Cathode Ray Tube* after the voltage has been cut off or the electron beam has moved away.

Ageing. A change in the properties of a substance which can be brought about mainly by lapse of time, but can sometimes be accelerated by other means. Thus the so-called ageing effect in transformer iron by which the hysteresis loss increases after a long period of use can be effected in a short time by heating to a suitable temperature; also the processes by which the *Sub-permanent Magnetism* can be quickly got rid of in the manufacture of permanent magnets for instruments is sometimes called an "ageing" process. See *NON-AGEING*.)

Agglomerate Leclanché Cell. A low resistance form of *Leclanché Cell* in which the depolariser is made up into blocks and surrounds the carbon electrode without a porous pot, and the negative electrode is in the form of an external zinc cylinder.

Agitation of the Electrolyte (in Electrodeposition). A more or less

rapid movement of the electrolyte towards the cathode to increase the permissible rate of deposit. Cf. CIRCULATION.

Agonic Lines. Lines on a magnetic map passing through points on the earth's surface where the magnetic *Declination* or *Variation* is zero. Cf. ISOGONAL, ISOCLINIC, and AGLINIC LINES.

Ah. Abbreviation of *Ampere-hour*.

Air-Blast Circuit-Breaker. A *Circuit-Breaker* in which a powerful blast of air is directed upon the gap between the contacts to extinguish the arc rapidly.

Air-Blast Transformer. A transformer with forced circulation of air over the windings etc., for cooling purposes. Cf. AIR-COOLED TRANSFORMER.

Air-Break Switch or Circuit-Breaker. A switch, etc., in which the contacts are separated in air. Cf. OIL-BREAK SWITCH.

Air-Calorimeter Test. A method of measuring the losses in an enclosed machine by ascertaining the volume of air passing through it and the difference of temperature at the inlet and outlet after a steady state has been attained.

Air-Compressor (Electric). An air-compressor driven by an electric motor such as is used for many purposes where it is desirable to combine the advantages of compressed air working with those of electric transmission, e.g. for railway and other brakes, for mining machinery, rock drills, etc., and for the working of various classes of pneumatic tools.

Air-Condenser. A condenser in which air at ordinary pressure acts as the dielectric. See also COMPRESSED AIR DIELECTRIC.

Air-Cooled Transformer. A transformer not immersed in oil in which the cooling air circulates naturally. Cf. AIR-BLAST, OIL-COOLED, and WATER-COOLED TRANSFORMERS.

Air-Core Choke, or Choking-Coil, Transformer, etc. A *Choking-Coil* or *Transformer* with no iron or other magnetic material in its magnetic circuit. Often used in high-frequency wireless circuits.

Air Duct. See VENTILATING DUCT.

Air Gap. A short interruption of the magnetic material in a magnetic circuit, such as the space between the surfaces of an armature and field magnet, or the rotor and the stator in dynamo-electric machinery, or the radial depth thereof. An air-gap is sometimes introduced into the magnetic circuit of a transformer when it is desirable that the magnetising ampere-turns and flux shall have a linear relation.

Air-Insulated Switchgear. Apparatus in which the principal insulation relied on is that of an air space.

Air Line. The usual form of telephone or telegraph line mounted on insulators on poles, as opposed to an underground circuit.

Air Space Cable. A form of lead covered multicore cable, used for underground telephone lines in which the conductors are separated from each other by paper and dry air; the air space forming the principal insulation. Cf. PAPER-CORE CABLE. Sometimes called *Dry-Core Cable*. Such cables require air, dried by passing over calcium chloride, to be periodically drawn through them by a *Desiccator*. They are of lower capacitance and are cheaper than corresponding cables with solid insulation.

Air Wires. The constituent wires of an elevated "wireless" aerial.

Airway Beacon. A powerful light to show the position of an air port or otherwise to mark a route for night flying, sometimes a revolving beam from a "lighthouse" and sometimes a fixed beam from a projector. The reddish light from a *Neon Lamp* has advantages of better penetration of fog than white light.

Aislometer. A form of electrostatic voltmeter used for high-voltage insulator testing.

Alarm, Burglar and Fire. See BURGLAR and FIRE ALARMS.

Albedo. A term sometimes used in photometry for the degree of diffused reflecting power possessed by a surface. An ideal white matt surface absorbing no light would have unit "albedo."

Aldrey. An alloy of aluminium containing magnesium of high tensile

strength, suitable for transmission lines.

Alexanderson Alternator. A high frequency alternator for wireless telegraphy, etc., of the high speed inductor type, which can give frequencies up to 1,000,000 cycles per second.

Alexanderson System of Phototelegraphy. A system of phototelegraphy characterised by the production of four grades of strength of the dots of which the reproduced picture consists, attained by superposing the effect a varying number of times during the four revolutions of the drum.

Alive (or Live). A conductor or circuit is said to be "alive" when connected to a source of e.m.f. Cf. *Dead*.

Alkaline Accumulator and Alkaline Cell. A secondary battery or cell in which an alkaline electrolyte is used. See EDISON and JUNGNER CELLS.

Allan Cell. An electrolytic cell used in America for the production of hydrogen by electrolysis of an alkaline solution.

All-Electric Signalling. Automatic or other railway signalling in which the signals are actuated as well as controlled electrically. Cf. *ELMOTRO-PNEUMATIC SIGNALLING*.

Allen's Loop Test. A modification of *Varley's Loop Test* for *Fault Localisation*, suitable for high resistance faults in short lengths of cable.

All-Insulated Switch. See SHOCK-PROOF SWITCH.

All-Mains Receiver. A wireless receiving set in which all the necessary supplies of voltage and current are drawn from the mains, including high and low tension, and grid bias; employing *Smoothing Circuits* and, in the case of a.c. supply, some form of *Rectifier*.

Alлотer. A switch which determines the order in which a group of *Selectors* in automatic telephony shall come into action.

Alloys: Aluminium, Heusler, High Permeability, Resistance, and Magnetic. See ALUMINUM ALLOYS, HEUSLER ALLOYS, etc.

Allstrom Relay. A very sensitive relay in which a slight deflection of

an extremely light magnetic system carrying a mirror, by an electro-magnet energised by the weak current to be detected, causes a beam of light to fall on a selenium cell producing a change of current therein which can actuate an ordinary relay.

All-Watt Motor. A form of induction motor with a phase advancer of the Scherbius type built into the rotor, giving practically unity power-factor.

Almalec. An aluminium alloy of high tensile strength suitable for transmission lines.

Alpha (α) symbol for *Absorption Factor* and *Decay coefficient*.

Alpha (α) Particles. Positively charged particles, consisting each of four protons and two electrons. Cf. BETA (β) PARTICLES and see ALPHA (α) RAYS.

Alpha (α) Rays. The least penetrating of the three principal kinds of rays given off by radioactive bodies, consisting of projected positively charged particles travelling at 10 to 20 thousand kilometers per second. They are slightly deflected by a magnetic field and are powerful ionisers. The bombardment of certain atoms by these rays can produce their break up and cause transmutation. Cf. β , γ , and δ rays.

Alternate Currents. A name used by some authors for *Alternating Currents*.

Alternating. Electric and magnetic quantities, such as current, voltage, flux, etc., are said to be "alternating" (as opposed to continuous) when their magnitude successively increases to a maximum in one direction, decreases to zero, increases in the opposite direction to a maximum of equal value and decreases to zero again, following the same cycle over and over again in a regular manner.

Alternating Current (A.C.) A current periodically reversing its direction of flow (see ALTERNATING); usually with a wave form approximating to a sine curve. The properties of alternating currents are somewhat different from those of continuous currents, and they are largely

used for power transmission. When such a current is produced by free oscillations at the natural period of the circuit, it is more commonly called an oscillating current. See also HIGH FREQUENCY CURRENTS.

Alternating Current Balancer. An autotransformer or other arrangement, connected across an a.c. three-wire system to maintain equality of voltage across the two sides, or in like manner to balance a direct current three-wire system by having the central point of its winding connected to the neutral point of a three-phase star-connected reactor connected to slip rings provided on one of the main generator armatures.

Alternating Current Bridge. A special form of *Wheatstone's Bridge* for alternating current measurements. In some cases a telephone receiver or a thermionic voltmeter replaces the galvanometer. See *SHERING BRIDGE*.

Alternating Current Commutating Motor. See *COMMUTATOR MOTOR*.

Alternating Current Conductivity (in a Condenser). The apparent conductivity of a condenser to alternating currents as measured by the conductivity which would enable a current to pass equal to that representing the dielectric losses.

Alternating Current Generator. A generator which produces *Alternating Current*. See references under *ALTERNATOR*.

Alternating Current Meter. A supply meter for use on alternating current circuits. See *MOTOR METER*, *INDUCTION METER*, etc.

Alternating Current Motor. A motor for running on an alternating current circuit. See *INDUCTION MOTOR*, *SYNCHRONOUS MOTOR*, *SINGLE-PHASE MOTOR*, *COMMUTATOR MOTOR*, etc.

Alternating Electromagnet. An electromagnet fed by alternating currents, having several properties not possessed by direct current electromagnets, such as repelling metal rings, etc., owing to the reaction of eddy currents induced therein.

Alternation. A term sometimes used

to signify that part of the change in an alternating current during which it rises to a maximum and falls to zero, i.e. half a complete *Cycle*. Cf. *PERIOD*.

Alternation Phonometer. An instrument for comparing sounds, in which the output circuits of similar receivers are connected to a single final output stage through two valves which are blocked alternately by an independent oscillator to give a flicker effect.

Alternator. An *Alternating Current Generator*. This term is sometimes limited to *Synchronous A.C. Generators*.

Alternator: Alexanderson, Bethenod-Latour, Compensated, Compound, Disc-Type, External Armature, Flywheel Type, Goldschmidt, Heyland, High Frequency, Homopolar, Inductor, Inner Pole Type, Internal Field, Magneto, Monocyclic, Monotooth, Multifrequency, Overhung Type, Panchronous, Polyphase, Reaction, Revolving Armature, Revolving Field, Single-Phase, Synchronous, Three-Phase, Trunnion Type, Turbo-, Two-Phase and Umbrella Type. See *ALEXANDERSON ALTERNATOR*, *BETHENOD-LATOIR ALTERNATOR*, etc.

Altitude Meter, Hot-Wire. See *HOT-WIRE ALTITUDE METER*.

Aludur. An aluminium alloy, containing magnesium, of high tensile strength, suitable for transmission lines.

Aluminium. This metal is frequently used instead of copper for overhead lines, switch-board connections and other purposes, on account of its weight for equal conductivity being about half that of copper. It cannot however be jointed quite so easily, and is liable to corrosion near the sea. Owing to the constant presence of a thin film of oxide on its surface, which has an appreciable insulating property, bare aluminium coils can be made use of with no further insulation between turns, and temporary telephone lines can be made of bare aluminium wire laid on the ground.

Aluminium Alloys. See *ALDREY*, *ALMALEC*, *ALUDUR*, *MONTÉGAL*, and *TELEOTAL*.

Aluminium Furnace. An electric furnace for the manufacture of aluminium by the electrolysis of bauxite in fused cryolite. E.g. the HÉROULT FURNACE.

Aluminium Rectifier. See NODON VALVE.

Aluminium-Steel Cable. Cable for aerial lines with a central core of steel surrounded by strands of aluminium; used for long spans where the tensile strength of aluminium is insufficient.

Amalgamation. In preparing zinc electrodes for primary cells, they are treated with mercury, which dissolves or "amalgamates" with the surface of the zinc, causing iron and other impurities to float off so that *Local Action* is avoided.

Ambroin. A moulded insulating material prepared from copal and silicates.

American System (of Transposition). A system in which the wires are run straight for a number of spans and are changed over at definite points varying according to the position of the wire or the arm, and the position of the arm on the pole. Cf. *Twist System*.

American Wire Gauge. See BROWN & SHARP WIRE GAUGE.

Ammeter. Shortened and more usual form of the word "Ampere-Meter." An instrument for measuring current, with a scale graduated to read directly in amperes. See ELECTROMAGNETIC, MOVING COIL, INDUCTION and HOT-WIRE INSTRUMENTS.

Ammeter, Polarised, Surge-Crest, Twisted Strip and Shunted. See POLARISED AMMETER, SURGE-CREST AMMETER, etc. See also references under INSTRUMENTS.

Ammeter Shunt. See SHUNT.

Amortisseur. See DAMPING COIL or GRID.

Amp. Abbreviation for *Ampere*.

Ampereage. An expression occasionally used for the current which a circuit is carrying or is designed to carry, expressed in amperes. Cf. VOLTAGE.

Ampere (A.). The practical unit of *Current* (named after the French physicist André Marie Ampère, 1775-1836). The true ampere is

one tenth of the C.G.S. electro-magnetic unit of current. The ampere can also be defined as the current produced by one volt applied to a conductor the resistance of which is one Ohm. See also INTERNATIONAL AMPERE.

Ampere Balance. A laboratory sub-standard current measuring instrument designed by Lord Kelvin, in which a sliding weight on a scale beam balances the force between a pair of coils carried on the beam and a system of fixed coils through which the same current is passing. Made in several sizes known as *Centi-ampere*, *Deka-ampere*, *Hecto-ampere* and *Kilo-ampere Balances*. Cf. COMPOSITE BALANCE.

Ampere-Conductors. See AMPERE-WIRES.

Ampere Gauge. A simple form of ammeter for rough purposes.

Ampere-Hour (Ah.). The commercial unit of quantity of electricity, being that which has passed when one ampere has been flowing for one hour or its equivalent (such as 2 amperes for half-an-hour). This unit is used for expressing the capacity of accumulators, etc.

Ampere-Hour Capacity. The capacity of an accumulator battery expressed in *Ampere-hours*, usually based on continuous discharge at a specified rate. See also IGNITION RATING.

Ampere-Hour Efficiency (of an Accumulator). The ratio of the quantity of electricity (in ampere-hours) obtainable during discharge to that put in during charging. Cf. WATT-HOUR EFFICIENCY.

Ampere-Hour Meter. A supply meter which takes into account only the average current passing and the time, irrespectively of any changes in voltage, even though it may be graduated to read kw-hours at an assumed constant voltage, e.g. *Electrolytic Meters* and *Motor Meters* with permanent magnets. Special forms of ampere-hour meter are used for measuring the input and output of accumulators.

Ampere-Meter. See AMMETER.

Ampère's Bucket. A pivoted metallic cylinder surrounding a magnet pole

to demonstrate rotation of a current round a magnet.

Ampère's Principle. The mutual attraction and repulsion of parallel wires carrying currents in the same or opposite directions respectively.

Ampère's Rule. The following rule to remember the direction in which a magnetic needle is deflected by current—if a man is swimming with the current and is facing the needle, the North seeking pole will be deflected towards his left hand. See also "SNOW RULE."

Ampère's Table. An old-fashioned piece of experimental apparatus in which a pivoted loop of wire carrying a current is employed to demonstrate the attraction between a magnet and a current, etc.

Ampère's Theory of Magnetisation. The assumption that magnetic property is due to circulatory current within the molecules of the magnet.

Ampere-Turns. The product of the number of turns (convolutions) composing a coil and the number of amperes flowing through it. It forms a convenient practical unit of *Magnetomotive Force*.

Ampere-Turns, Cross and Field. See CROSS AMPERE-TURNS and FIELD AMPERE-TURNS.

Ampere-Wires. An expression sometimes used in dynamo design for the product of the number of conductors, per slot, per pole, etc., and the current in amperes carried by each.

Amphoteric Electrolyte. An electrolyte which can be dissociated in two alternative ways.

Amplification. See AMPLIFIER.

Amplification, Audio-Frequency, Class B, Dual, Energy, High Frequency, Linear, Low Frequency, and Radio-Frequency. See AUDIO-FREQUENCY AMPLIFICATION, CLASS B AMPLIFICATION, etc. See also references under AMPLIFIER.

Amplification Constant or Amplification Factor (1) of a thermionic valve. The ratio between the slopes of the anode current-grid voltage and the anode current-anode voltage curves under identical conditions. (2) Of an amplifier in general. The ratio between the

changes of current voltage or power on the input and output sides. Symbol: μ .

Amplification of Modulated High Frequency. A method of wireless telephony transmission, particularly for large broadcasting stations, in which *Choke Control* is not employed directly upon the main oscillating circuit but upon a small scale. The output is then amplified but several high frequency stages until the requisite power for the aerial is reached.

Amplifier. An apparatus capable of delivering a variable current in which the scale of the variations is much greater than that of the variations in the c.m.f. supplied to it; and thus capable of being used to reinforce or "amplify" the effect of weak electrical oscillations; employed for this purpose extensively in wireless telegraphy and in both wireless and line telephony. Sometimes called a *Magnifier*.

Amplifier: Cascade, Contrast, Note, Magnetic, Microphone, Multistage, Polystage, Power, Resistance, Resistance-Coupled, Resonance, Speech, Thermionic, and Valve. See CASCADE AMPLIFIER, CONTRAST AMPLIFIER, etc. See also references under AMPLIFICATION.

Amplitude. An expression sometimes used for the peak value attained in either direction by a quantity executing periodic oscillations, such as an alternating current, and sometimes for the sum of the positive and negative values, especially when equal. The latter is preferably called *Double Amplitude*.

Amplitude Distortion. Alteration of the quality of reproduced sound in wireless telephony due to reproduction of different amplitudes at the same frequency in different ratios. Some writers use the term to include *Frequency Distortion* and to distinguish from *Phase Distortion*.

Amplitude Factor. See PEAK FACTOR.

Analogous Pole. The part of a *Pyro-Electric Crystal* which becomes positively electrified when the temperature is rising, and negatively electrified when the

temperature is falling. Cf. **ANTI-LOGOUS POLE**.

Analyser, Harmonic and Sound. See **HARMONIC ANALYSER** and **SOUND ANALYSER**.

Analysis, Electrometric. See **ELECTROMETRIC ANALYSIS**.

Anaphoresis. *Electrophoresis* in which the particles in question pass towards the anode. Cf. **CATAPHORESIS**.

Anchor, Conductor Rail and Side. See **CONDUCTOR RAIL ANCHOR** and **SIDE ANCHOR**.

Anchor Gap. A small protective spark gap in the aerial circuit across which the powerful surges when transmitting can jump without damaging the receiving instruments.

Anchor Poles or Towers. Poles or towers supporting overhead lines, which take the stress along the wire and prevent longitudinal movement.

Ancillary Jacks, Lamps, etc. Additional jacks, lamps, etc., all connected to a subscriber's line, on different panels on a telephone switch-board by means of which any one of a number of operators who happens to be disengaged can attend to a subscriber's call without loss of time.

Anderson's Bridge. A bridge method of measuring inductance in which the inductance to be measured is included in one bridge arm with a condenser between the opposite battery terminal and a point between the galvanometer and a resistance in series with it.

Anelectric (or Non-electric). Old-fashioned term for a body which does not become electrified by friction, i.e. the reverse of a *Dielectric* or a *Conductor*.

Anelectrode. An old-fashioned term for the positive pole of a battery. Cf. **CATELECTRODE**.

Anelectrotonus. The condition of decreased irritability assumed by a nerve near the positive electrode when a constant current is passed through it. Cf. **CATELECTROTONUS**.

Anemometer, Glow-Discharge and Hot Wire. See **GLOW-DISCHARGE ANEMOMETER** and **HOT WIRE ANEMOMETER**.

Angle, Polar or Pole. See **POLE ANGLE**.

Angle of Lag. The angle by which the current in an inductive a.c. circuit lags behind the voltage producing it. See **PHASE DIFFERENCE**, **POWER FACTOR**, etc.

Angle of Lead. (1) The angle by which the current in an a.c. circuit leads in front of the voltage, e.g. when the circuit is of considerable capacity. (2) The angle by which the brushes in dynamo-electric machinery have to be shifted from the geometric neutral position to compensate for armature reaction and to ensure sparkless commutation.

Ångström Unit. A unit of length sometimes used for wave lengths, etc., equal to 10^{-8} centimetre.

Cf. **MICRON**. Abbreviation: **Å**.

Animal Electricity. The power possessed by certain animals of giving powerful electric shocks to their enemies. See **EEL (ELECTRIC)**, etc.

Animal Magnetism. A term sometimes used to describe psychic phenomena which really have no connection with magnetism.

Anions. The dissociated parts of molecule, or *Ions* carrying negative charges which during electrolysis move towards the *Anode*. Cf. **CATIONS**.

Anisotropic Conductivity. Conductivity which is different in different directions in a body. Cf. **UNILATERAL CONDUCTIVITY**.

Annual Variation. The changes in the earth's magnetism corresponding with the earth's movement round the sun.

Annunciator. See **INDICATOR**.

Annunciator Drop. See **INDICATOR DROP**.

Anode. The pole or electrode through which, according to the old convention, the current enters an electrolytic cell, vacuum tube or other piece of apparatus, i.e. the *Positive Pole*, where the electrons leave the medium. In the case of a primary cell, the electrode through which the current enters the electrolyte, i.e. the zinc or other negative pole is sometimes called the

- "Anode." From Greek words meaning literally "the way up." See also PLATE.
- Anode, Supplementary and Zero-Point.** See SUPPLEMENTARY ANODE and ZERO-POINT ANODE.
- Anode A.C. Conductance.** The reciprocal of *Anode A.C. Resistance*.
- Anode A.C. Resistance** (of a Thermionic valve). The ratio of a small change in anode voltage to that of anode current, all other quantities being constant. Symbol: r_a .
- Anode Battery.** The battery which supplies a high direct current voltage between the anode and the cathode of a *Thermionic Valve*.
- Anode-Bend Rectification.** *Anode rectification* by a thermionic valve in which the grid potential is so adjusted that the valve works in the region of the lower bend of the anode-current characteristic.
- Anode Circuit.** See PLATE CIRCUIT.
- Anode Circuit, Tuned.** See TUNED PLATE CIRCUIT.
- Anode Conductance.** The reciprocal of *Anode Resistance*.
- Anode Converter.** A small *Converter* for obtaining a high continuous current voltage for the anode circuit of a thermionic valve.
- Anode Coupling, Tuned.** See TUNED ANODE COUPLING.
- Anode Current.** The ionic current flowing between the anode and the other terminals in a thermionic valve. See also THERMIONIC CURRENT. Symbol: I_a or i_a .
- Anode-Current Characteristic** (of a Thermionic Valve). A curve connecting simultaneous steady values of (1) anode-current and grid-voltage and (2) anode-current and anode-voltage, all other variables remaining constant. Cf. GRID-CURRENT CHARACTERISTIC.
- Anode-Current Surface** (of a Thermionic Valve). A surface connecting coordinates representing simultaneous values of anode current, anode-voltage and grid-voltage. Cf. GRID CURRENT SURFACE.
- Anode Dissipation.** The power absorbed in heating the anode of a *Thermionic Valve*.
- Anode D.C. Resistance.** The ratio of the steady anode voltage and anode current all other quantities being constant. Symbol: R_a .
- Anode Effect** (in Electrolysis). A sudden drop of the current due to the formation of a film of gas on the anode.
- Anode Glow.** A slight glow seen on the anode of a vacuum tube at high degrees of exhaustion but disappearing when the gas pressure is below 1/10,000 of an atmosphere.
- Anode Impedance.** A term for what is better called *Anode A.C. resistance*.
- Anode Modulator.** A modulator in a wireless transmitting apparatus which acts by applying variations of the microphone current to the anode circuit of the oscillating valve through a *modulating valve* circuit. See CHOKK MODULATOR.
- Anode Pickling.** Removal of surface impurities from metal objects by making them act as the anodes in an electrolytic cell.
- Anode Rays.** See POSITIVE RAYS.
- Anode Rectification.** Rectification of a thermionic valve in which the oscillations to be rectified are applied to the *Plate Circuit*. Cf. GRID RECTIFICATION.
- Anode Resistance** (of a Thermionic Valve). See ANODE A.C. RESISTANCE and ANODE D.C. RESISTANCE.
- Anode Resistor.** See RESISTANCE-CAPACITANCE COUPLING.
- Anode Tapping Point.** The point on the inductance in the main oscillating circuit of a valve transmitter connected to the anode of the valve.
- Anode Voltage** (in a Thermionic Valve). The voltage between the anode (plate) and the negative terminal of the filament. Symbol: V_a or v_a .
- Anodic.** See ELECTRONEGATIVE.
- Anodic Oxidation.** The electrolytic production of a film of oxide on a metal.
- Anodic Production of Solids.** Electrodeposition of an insoluble compound of the metal of the anode in an electrolytic cell.
- Anolyte.** The part of the electrolyte in an electrolytic cell in close proximity to the anode. Cf. CATHOLYTE.

Anomalous Charging Current (in a Condenser). The gradually decreasing current which continues to flow into a condenser after the *Normal Charging Current* has ceased (in addition to any normal or anomalous conduction current) due to the effect of so-called *Dielectric Absorption*.

Anomalous Conduction (in a Condenser). The property of a condenser of permitting a varying current to flow through it, representing energy not recoverable on discharge in addition to the *normal and anomalous charging currents* and the *normal conduction current*.

Anomalous Conduction Current (in a Condenser). The varying component of current which sometimes flows through a condenser due to *Anomalous Conduction*.

Anomalous Discharge Current (in a Condenser). The current which continues to flow from a condenser due to the effects of so-called absorption, etc., after the normal discharge current has ceased.

Anomalous Displacement. The electric *Displacement* in a condenser, due to the anomalous charging current and representing energy recovered gradually after the normal discharge in the anomalous discharge current.

Anomalous Magnetisation. An irregular distribution of magnetisation where consequent poles exist as well as two main poles.

Anotron. A vacuum-tube rectifier of the cold cathode glow discharge type with a large cathode of sodium or other material and a copper anode.

Antenna. See *AERIAL*.

Anti-Capacitance Switch, Valve Holder, etc. A switch, valve holder, etc., for wireless apparatus, designed to have as little capacitance as possible.

Anti-Cathode. The "target" in an "X" *Ray Tube*, where the rays are produced by the bombardment of the *Cathode Stream*.

Anti-Coherer. See *SELF-RESTORING COHERER*.

Anti-Fading Device (in Wireless Receivers). An arrangement to com-

pensate temporary loss of signal strength due to fading, e.g. *Automatic Volume Control*.

Antifatigue Device (in Transmission Lines). An attachment to a line conductor at its point of suspension to take the bending and shearing stress produced by vibration of the conductor, and to prevent mechanical failure due to fatigue. Cf. *ANTI-VIBRATION DEVICE*.

Antidyne Circuit. A circuit for a *Thermionic Oscillator* in which *Reversed Coupling* is used between the plate and grid circuits. Cf. *ORTHODYNE* and *RHEODYNE CIRCUITS*.

Anti-Fading Aerial. An aerial designed to omit radiation chiefly at low angles to avoid interference with the ground waves of downcoming waves reflected from the ionosphere.

Anti-Interference Condenser. A condenser connected across a motor or other piece of apparatus to smooth out the effect of current irregularities due to its working which produces interference in neighbouring wireless receiving apparatus.

Antilogous Pole. The part of a *Pyro-Electric Crystal*, which becomes negatively electrified when the temperature is rising, and positively electrified when the temperature is falling. Cf. *ANALOGOUS POLE*.

Anti-Microphonic Valve Holder. A holder for thermionic valves, supported on springs, etc., to minimise the communication of mechanical vibration to the filament and thus to reduce liability to *microphonic noise*.

Anti-Nodes. Maximum points in *stationary waves* or oscillations in a conductor, also called *Loops* and *Internodes*.

Anti-Secondary Grid. An additional *Grid* in a thermionic valve kept at a suitable voltage relatively to the anode to prevent *Secondary Emission*.

Anti-Spray Film. A floating film of a special kind of oil on the surface of the electrolyte in accumulator cells to prevent the formation of acid spray by the bursting of bubbles.

Anti-Static Aerial. An aerial arranged to diminish the effect of load interference and other parasitic waves by special screening and other precautions.

Anti-Sulphating Accumulator. A lead accumulator in which the positive and negative plates are separated by a membrane permeable to ions but not to molecules, thus preventing access of oxygen to the negative plates.

Anti-Vibration Device (in Transmission Lines). Some form of mechanical damper to lessen vibration in overhead conductors.

Anti-Vibration Lamp-Holder. See ANTI-MICROPHONIC LAMP-HOLDER.

Aperiodic Aerial. A term sometimes applied to an aerial circuit with no tuning arrangements therein, inductively coupled to a tuned circuit.

Aperiodic Circuit. A circuit which can have no natural period of oscillation, i.e. where $4L$ is less than R^2C (where L is the inductance, R the resistance and C the capacitance in farads.) Cf. OSCILLATING CIRCUIT.

Aperiodic Instrument. An indicating instrument such as a galvanometer is said to be "aperiodic," when the moving system has no natural period of swing and therefore cannot take up oscillations before coming to rest in a new position. Cf. DEAD BEAT.

Aphengescope. See REFLECTOSCOPE.

"A" Pole. A support for overhead lines, made of two wooden poles braced together, touching at the top and splayed apart at the bottom. Cf. "H" POLE.

Apostilb. A name sometimes given to the unit of brightness otherwise known as the *Lambert* due to its value of $1/\pi$ stilb.

Apparent Efficiency. The ratio of the output of a piece of alternating current apparatus in true watts to the input in volt-amperes.

Apparent Impedance. The ratio of voltage to current under such special conditions as those of short circuit of an alternator.

Apparent Inductance. The value of the inductance which a coil in an oscillating circuit would have to

produce the same oscillation frequency as an actual coil, if it had no *Self-Capacitance*.

Apparent Power. The product of voltage and current irrespective of the power-factor, in an alternating current circuit, expressed in volt-amperes.

Apparent Remanence. The *Remanence* as observed in the case of an open magnetic circuit such as that of a horseshoe or bar magnet, where there is considerable self-demagnetising force. Cf. TRUE REMANENCE.

Apparent Resistance. See IMPEDANCE.

Apparent Wats. See APPARENT POWER.

Apple-Shaped Diagram. See DIAGRAM OF RECEPTION.

Appleton Layer. An ionised layer in the upper atmosphere, considerably above the *Kennelly-Henviside Layer* and of greater but variable electrical density, capable of causing the reflection of waves of length too short to be reflected by the *Kennelly-Henviside* layer. It may be regarded as being divided into the "F₁" layer, about 180 km. up, existing only in the daytime, and the more heavily ionised "F₂" layer, about 250 km. up.

Applied E.M.F. or Applied Voltage. See IMPRESSED VOLTAGE.

Arago's Disc. See ARAGO'S ROTATIONS.

Arago's Rotations. In experiments conducted before the discovery of induced currents by Faraday, D. F. J. Arago (1786-1853) found that a rotating copper disc, underneath a pivoted magnet, tended to drag the magnet round with it as if there were some action analogous to friction between them. The experiment was supposed, at the time, to indicate that magnetism could be produced by mere rotary motion, but the effect is really due to the reaction of the induced *Eddy Currents*.

Arbitrary Units. Units not dependent upon any relationship with absolute units, such as the (obsolete) *Siemens* or *Jacobi Units* of resistance.

Arc. The passage of a current between two separated electrodes

of carbon or other material through the ionised vapour produced by their volatilisation. This is accompanied by great development of heat, and temperatures as high as 4,000°C. are produced. The brilliant light from the heated electrodes, and to some extent from the arc itself, is used in arc lamps; its heating effect is used in electric furnaces and electric welding. (Discovered by Sir Humphrey Davy, 1778-1829.)

Arc : Carbon, Duddell, Flame, Flaming, Flash, Multiple, Polar, Pole, Poulsen, and Singing. See CARBON ARC, DUDDELL ARC, etc.

Arc Deflector. (1) A magnetic system employed to control the position of the arc in an arc lamp. In some projector lamps, this consists simply of a curved piece of iron which is rendered magnetic by the current through the arc itself. (2) A plate of fire-proof material employed to confine the arc formed on breaking a circuit at the contacts of switches, controllers, etc., also called *Arc Shield*.

Arc Furnace. An electric furnace, in which the heat is produced by an arc between carbon electrodes or between an electrode and the molten charge in the furnace. See HÉROULT FURNACE, GIROD FURNACE, STASSANO FURNACE, etc.

Arc Furnace, Direct and Indirect. See DIRECT ARC FURNACE and INDIRECT ARC FURNACE.

Arc Generator. Apparatus for producing electric waves for wireless telegraphy and telephony by the *Arc System*.

Arc Lamp. An apparatus provided with automatic or hand regulated mechanism for controlling the position of carbon or other electrodes so that an arc is maintained between them for the useful production of light. The mechanism has two functions: to strike the arc by bringing the tips of the carbons together and to separate them by a short distance as soon as the current is established, and to feed them forward as they burn away and thus to maintain

the correct length of the arc for steady burning. See also ARC LIGHTING.

Arc Lamp : Automatic, Beck, Blondel, Brake-Wheel, Bremer, Carbon, Clutch, Differential, Enclosed Flame, Flame, Flaming, Focusing, Enclosed, Hand-Regulated, Hot-Wire, Inclined Carbon, Intensified, Inverted, Jandus, Luminous, Magazine, Magnetite, Open, Open Flame, Regenerative, Series, Series-Wound, Shunt, Titanium Carbide, Tungsten, Twin-Carbon, and Vertical Carbon. See AUTOMATIC ARC LAMP, BECK ARC LAMP, etc.

Arc Lamp Carbon. A carbon rod to be used as an electrode in an arc lamp, made by an extrusion process from a mixture of several forms of finely-divided carbon with a binder of tar or similar material afterwards baked. Sometimes with a core of other material and sometimes with the addition of chemical substances. See references under CARBON.

Arc Light. See ARC LAMP.

Arc Lighter. A constant current dynamo specially constructed for the supply of current to a number of arc lamps in series. Well-known examples in the early days of arc lighting include the Thomson-Houston spherical armature machine and the Brush discoidal armature machine.

Arc Lighting. Lighting by means of *Arc Lamps*. The earliest form of electric lighting, first demonstrated publicly about 1844 in Paris, but not used on a commercial scale till about 1880, now largely superseded by metal filament lamps.

Arc Lighting, Series System of, and Rectifier System of. See SERIES ARC LIGHTING and RECTIFIER SYSTEM OF ARC LIGHTING.

Arc Lighting Dynamo. See ARC LIGHTER.

Arc Process (of Nitrogen Fixation). The process in which nitrogen from the air is directly oxidised by the heat of an electric arc to form nitric oxides which subsequently form HNO_3 by contact with water. See BIRKELAND and EYDE, SCHOENHER, MOSCICKI, PAULING, ISLAND and KILBURN SCOTT FURNACES,

and cf. CYANIDE and SYNTHETIC AMMONIA PROCESSES.

Arc Rectifier. (1) A rectifier in which an arc struck between suitable electrodes is so controlled as to be during the current wave in one direction only, e.g. the *Marx Rectifier*. (2) A style of rectifier similar in principle to the thermionic rectifier except that the cathode is heated by the current itself and not by an external source.

Arc Relay. A relay depending on the variations in behaviour of a mercury vapour arc according to the potential of an additional electrode.

Arc Shield. A partition of fire-proof material to confine the arc produced by breaking heavy currents in controllers, contactors, circuit-breakers, etc., in order to protect neighbouring apparatus from damage. Also called *Flashguard* or *Barrier*.

Arc Stream. The stream of negatively charged *Ions* which proceeds from the *Cathode* across the intervening space to the *Anode* in an arc, and accounts for its conductivity.

Arc System of Wireless Telegraphy. A system in which *Continuous Waves* are produced by connecting an *Oscillating Circuit* to an arc of special character so that advantage is taken of certain relations between the current through the arc and the voltage between its electrodes to produce an instability resulting in the continuance of oscillations. See DUNDELL ARC, POULSEN ARC, etc. Arc systems on the same general principles but differing in detail, are known under the names of Poulsen, Elwell, Telefunken, Federal (U.S. Navy), Colin Jeanco, Moretti, Ruhmer and Dubilier.

Arc-Stream Voltage. A term used in *Arc Welding* for the voltage drop along the arc-stream itself, not including the drops at the electrodes. Cf. TRUE-ARC VOLTAGE.

Arc Suppressor. See PETERSEN COIL.

Arc Transmitter. A wireless transmitting apparatus employs an arc as the source of the oscillations (see above). Cf. SPARK TRANSMITTER and VALVE TRANSMITTER.

Arc Voltage, True (*Electric Welding*). See TRUE ARC VOLTAGE.

Arc Welding. Systems of electric welding in which the localised heat is produced by an arc, either between a movable electrode and the work itself or between two separate electrodes.

Arc Welding, Carbon, Metallic, and Shielded. See CARBON ARC WELDING, METALLIC ARC WELDING, etc.

Arcing (of a switch, etc.). The production of an arc across the contacts when they are separated to break the circuit, resulting in the burning away of the contacts and other damage if allowed to persist. Special arrangements are therefore adopted to prevent the continuance of any arc formed in this way. See QUICK-BREAK SWITCH, MAGNETIC BLOW-OUT, ARCING HORNS, ARCING TIPS, etc.

Arcing Back. See BACK-FIRING.

Arcing Contact. See AUXILIARY CONTACT.

Arcing Ground. An expression used for a temporary fault to earth (ground) on a transmission system due to an arc forming between a line conductor and an earthed fitting, started by a voltage surge or otherwise.

Arcing Horns. Diverging, upwardly projecting extensions similar to those of the well-known *Horn Arrester*, attached to the contacts of a switch or circuit-breaker. The arc formed on breaking the circuit travels rapidly to the tops of the horns where they are widely separated and extinguishes itself.

Arcing Horns, Insulator. See INSULATOR ARCING HORNS.

Arcing Ring. A metal ring mounted at the end of a string of insulator units to take the arc of a flash-over.

Arcing Spark. A term sometimes used in wireless telegraphy for an insufficiently quenched spark in which an arc drawing current direct from the transformer follows the original spark. See DEIONISATION.

Arcing Tips. Renewable pieces of carbon, or other material, attached to the contacts of switches, circuit-breakers, etc., to take the arc on breaking circuit.

Arching Voltage. The voltage below which an arc cannot be formed between given electrodes under given conditions.

Arcronograph. An apparatus for recording the exact cycle of current and voltage occurring in the circuit supplying a welding arc, during the making of a weld, in order to gauge the quality of the weld; employing a *thermionic valve* as relay.

Armature. A piece of iron either with or without a winding which is attracted to or moved relatively to a permanent or electro-magnet; thus including: (1) The piece of iron or *Keeper* commonly kept across the poles of a permanent magnet to avoid the self demagnetising effect of leakage lines. (2) The iron portion which is attracted by the electromagnet in electromagnetic mechanisms such as *Bells, Relays, Contactors*, etc. (3) The iron-cored portion provided with a winding of wire or other conducting system which rotates between or is surrounded by the poles of the field magnet in a direct current *Dynamo, Motor*, or similar machine, or in a stationary field *Alternator*. (4) The stationary portion composed of an iron core provided with a winding in which the current is induced in a revolving field alternator. The expression also includes the moving conductor systems in certain of the older designs of alternator in which the revolving portion did not contain any iron, and is also occasionally employed for a conductor acted upon by electrostatic forces as in an *Influence Machine*.

Armature: Bar-Wound, Closed Coil, Coreless, Disc, Discoidal, Drum, "H," Ironless, Open Coil, Polarised, Ring, Shuttle, Siemens, Single Wound, Slotted Core, Smooth Core, Spherical, Stationary, Strip-Wound, Tunnel-Wound, and Wire-Wound. See BAR-WOUND ARMATURE, CLOSED COIL ARMATURE, etc.

Armature Bands. Bands of steel wire, etc., over an armature to keep the conductors in place against centrifugal force; usually laid on

under tension over mica insulation and held by clips as well as being soldered together.

Armature Bars. The copper conductors of rectangular section which take the place of wires in armatures with few conductors per slot.

Armature Coil. The portion, forming a unit of an armature winding, consisting of one or more turns, which commences at one commutator segment and terminates at another. (For different kinds of armature coils, see *COIL*.)

Armature Conductor. Each single wire or bar extending from one end of an armature to the other. An armature winding is spoken of as having so many conductors per slot; usually double the number of the turns per coil.

Armature Core. The laminated body of an armature, usually consisting of slotted core discs or plates, with or without special insulating material between them to minimise eddy-currents, held tightly between end plates.

Armature Core Discs. Complete circular laminations, usually ready punched with slots, for building up armature cores.

Armature Core Discs, Segmental. See SEGMENTAL CORE DISCS.

Armature Core Plate. The special quality of sheet steel or iron used for armature cores.

Armature Core Plates. See ARMATURE STAMPINGS.

Armature Ducts. Channels in the armature core provided for the circulation of cooling air.

Armature End Connections. The portions of an armature winding which join individual conductors in different slots together at the end of the armature, and thus do not themselves cut the lines of force. In wire-wound armatures they form parts of the coil themselves, but in bar wound armatures they are separate portions connected up in place.

Armour Clamp or Gland. A clamping arrangement to ensure metallic contact between the armouring wires of a cable and the body of a junction box.

Armature End Plates. The substantial plates which clamp the laminations firmly together by bolts; or, in small armatures, by nuts on the shaft.

Armature Head. See ARMATURE END PLATE.

Armature Keys. (1) Keys to prevent an *Armature Core*, *Sleeve*, or *Spider* rotating on the shaft. (2) Wooden or other strips in notches in the slots to hold the armature conductors against centrifugal force. Also called *Slot Wedges*.

Armature Punchings. See ARMATURE STAMPINGS.

Armature Reaction. The modification in the distribution of the flux due to the armature ampere turns.

Armature Shaft. The shaft or spindle upon which, in small armatures, the core discs are assembled, or in large armatures, the sleeve or spider is carried.

Armature Sleeve. The sleeve, usually of cast iron, upon which the laminations are assembled to form the core in medium sized machines.

Armature Slot. One of the axial channels in the surface of armature cores in which the conductors are placed; usually formed by the punching of regularly spaced notches in the core plates before assembly. See OPEN SLOTS, CLOSED SLOTS, HALF-CLOSED SLOTS, etc.

Armature Spider. A casting with spokes upon which the laminated core is built up, carried, in the case of large armatures, by the shaft.

Armature Spindle. See ARMATURE SHAFT.

Armature Stampings. The finished plates or discs from which the core is built up.

Armature Winding. The complete system of interconnected conductors carried by an armature, and connected, in the case of direct current machines, to the commutator.

Armed Lodestone. A *Lodestone* fitted with iron pole-pieces, or "helmet," to concentrate the field.

Armoured Cable. Cable, generally intended to be laid directly in the ground, covered with *Armouring*.

Armouring (of a cable). An external

covering, usually made of steel wire or bands, to give mechanical protection.

Arm: Bracket, Brush and Ratio. See BRACKET ARM, BRUSH ARM, etc.

Armstrong Circuit. A wireless receiving circuit in which *Retraction* is made use of to improve the sensibility.

Armstrong-Orling Detector. See CAPILLARY DETECTOR.

Arno Meter. A specially arranged electricity supply meter for a system of charging in which the power-factor is taken into account by making a charge at a lower rate for the wattless current. Part of the resistance of the voltage circuit in the meter is replaced by an inductance producing a lag, α , so that $EI \cos(\phi - \alpha)$ is measured instead of $EI \cos \phi$.

Aron Meter. An electricity supply meter in which two clock movements are employed, connected through a differential gear to a counting train. The relative rates are controlled according to the current passing by the action of a coil which slows down the pendulum of one of them.

Array, Aerial and Beam. See AERIAL ARRAY and BEAM ARRAY.

Arrester. An apparatus provided to divert to earth sudden discharges due to the effect of lightning or other surges of excess voltage without allowing the current in the circuit to follow the discharge to earth.

Arrester: Confined Discharge, Comb, Electrolytic, Gap, Garton, Horn, Lightning, Multigap, Spray, Surge, Water-column, Water-jet and Wurtz. See CONFINED DISCHARGE ARRESTER, COMB ARRESTER, etc.

Arrester. Alternative spelling for *Arrester*. (See note under *Starter*.)

Arrival Curve. A curve showing the manner in which the current impulse received at the end of a telegraph cable, of considerable resistance and capacitance, gradually builds up to its final value. Sometimes called *Kelvin* (or *Thomson*) *Arrival Curve*.

Articulated Locomotive. An electric locomotive, composed of more than

one unit, each with its own main frame, coupled together to give flexibility to the wheel base.

Artificial Aerial. A combination of capacitance and inductance equivalent to that of an aerial, used to test transmitting apparatus without radiating waves. Also called *Dummy Aerial*.

Artificial Daylight. "Artificial" light of approximately the same spectrum or composition as daylight.

Artificial Line. A combination of resistors, inductors and capacitors as a *network*, having the same constants as an actual telegraph or telephone line.

Artificial Load. A liquid or other resistance capable of dissipating a large amount of energy, for testing generators under full load conditions.

Artificial Magnet. A magnet of steel which has been magnetised as opposed to a *Natural Magnet* or *Lodestone*.

Artificial Sunlight. Light from special arc, mercury vapour or other lamps particularly rich in ultraviolet rays; having considerable health-giving and curative properties when suitably applied.

"A" Side (in Telegraphy). The double current circuits in quadruplex working. Cf. **"B" Side**.

Association Cable. Insulated cable constructed according to the standards of the Cable Makers Association.

Astatic Galvanometer. A galvanometer in which the moving part consists of a pair of needles magnetised equally in opposite directions, one or both of which are deflected by the current in fixed coils. See **ASTATIC SYSTEM**.

Astatic Needle. The needle of an astatic galvanometer or similar instrument.

Astatic System. A magnetic system in which the polarities of the component portions are arranged to cancel one another, so that there is no resultant polarity, and no directive force is experienced in a uniform magnetic field. See **ASTATIC GALVANOMETER**, **BROCA GALVANOMETER**, etc.

Asylum Switch. See **LOCKED COVER SWITCH**.

Asymmeter. An instrument consisting of three movements suitably combined so that current or voltage symmetry of a three-phase system can be indicated by a single observation.

Asymmetric Conductor. A conductor of different conductivity to currents flowing in different directions.

Assymmetrical Effect (in Wireless Telegraphy, etc.). See **LACK OF SYMMETRY ERROR**.

Assymmetrical Voltage. A polyphase voltage system in which the instantaneous sum of the voltages in the various phases is not always zero.

Asynchronous Condenser. An induction motor combined with a phase-advancer used for power-factor improvement.

Asynchronous Generator and Asynchronous Motor. See **ASYNCHRONOUS MACHINE**.

Asynchronous Machine. An alternating current motor or generator which does not have to run at a speed which is an exact multiple of the frequency of (i.e. in synchronism with) the circuit, e.g. an *Induction Motor* or an induction generator. The term *Non-Synchronous* is sometimes preferred.

Asynchronous Spark Gap. A *Rotary Spark Gap* without provision for the sparks to occur at definite points in the cycle of the a.c. supply.

A.T. Abbreviation for *Ampere-Turn*.

Atlantic Cable. A submarine telegraph cable laid in the bed of the Atlantic Ocean. Although the first Atlantic Cable was laid in 1858, permanent telegraphic communication was not established between Britain and America until 1866. There are now 15 cables across the Atlantic.

Atmospheric Disturbances. See **ATMOSPHERICS**.

Atmospheric Electricity. The electric potentials which exist in the atmosphere. It appears that the earth has a permanent negative charge of about 700,000 coulombs, replenished in an unknown way,

while a loss of charge corresponding to a current of 1,000 amperes through the atmosphere is going on. This produces a potential gradient averaging about 150 volts per metre at low altitudes, but is subject to great and irregular diurnal variation and even change of sign, apart from temporary effects of rain and thunderstorms.

Atmospherics. The irregular signals which are received in wireless telegraphy and are liable to interrupt ordinary communication, due to stray electric waves and alterations in the electrical state of the atmosphere, caused mainly by distant thunderstorms and sometimes perhaps by auroral and other currents in the upper atmosphere.

Atom. The unit of matter from which molecules are made up; consisting, according to the Rutherford-Bohr theory, of a number of *Electrons* or units of negative electricity revolving in elliptical orbits round a nucleus composed of *Protons* and *Neutrons*. Other theories conceive of the outer system as an electronic cloud.

Atomic Hydrogen Welding. Welding by an intensely hot flame, produced by the recombination of hydrogen atoms which have been dissociated by passing through an electric arc.

Atomic Number. The number of electrons circulating in orbits around the nucleus of an atom (not including any which may form part of the nucleus). (Cf. **MASS NUMBER**.)

Atomic Interrupter. An interrupter for induction coils, etc., which can be adjusted over a wide range of frequency.

Attenuation. The diminution of the amplitude of electric waves at progressive distances from the source including in the case of waves propagated along telephone lines or cables of considerable capacitance, when it results in diminished audibility. (Cf. **DISTORTION**.) The attenuation due to a line is expressed in *Neper*s or *Bels* or in terms of miles of *Standard Cable* to which the line is equivalent.

Attenuation, Geometric. See **GEOMETRIC ATTENUATION**.

Attenuation Compensator or Equaliser.

A combination of resistance, inductance and capacitance to compensate for the variation of attenuation with frequency in a line.

Attenuation Constant. The property of a cable on which the amount of attenuation produced depends, measured by $\sqrt{\{\frac{1}{2}[\sqrt{(R^2 + p^2 L^2)}(S^2 + p^2 C^2) + (SR - p^2 LC)]\}}$ where R = resistance per mile, $p = 2\pi n$ (n = frequency), L = inductance (in henries per mile), C = capacitance (in farads per mile), and S = dielectric conductivity (in mhos per mile). The attenuation constant can also be defined as the reciprocal of the length of the line in which the amplitude is reduced in the ratio of 2.71828 to one.

Attenuation Factor. The ratio of the received amplitude to the initial amplitude, measured by e^{ax} where a = the attenuation constant of the circuit and x = the distance.

Attenuation Length. The product of the attenuation constant and the length of the line in miles.

Attenuator. A resistor introduced into an oscillating circuit to reduce the amplitude of the oscillations therein.

Attracted Disc Electrometer. See **ABSOLUTE ELECTROMETER**.

Attraction, Electrostatic and Magnetic. See **ELECTROSTATIC ATTRACTION** and **MAGNETIC ATTRACTION**.

Å. U. See **ÅNGSTRÖM UNIT**.

Audibility. The degree to which a particular signal is audible in a telephone receiver, in wireless telegraphy; measured in practice by ascertaining the resistance of a shunt, S , which must be put across a telephone receiver of resistance R to render the sound only just audible. The audibility then equals $(R + S)/S$.

Audibility Current. The minimum *Audio-current* which can give a distinct signal at a particular frequency in a given telephone receiver.

Audible Ringing Signal. See **RINGING TONE**.

Audio-Current. The alternating component in a telephone current, i.e. the component representing the

Modulations without the Carrier Current.

Audio-Frequency. A frequency within the range at which telephone currents can produce audible sounds in a receiver, i.e. between about 25 and 10,000 cycles per second. Cf. VOICE FREQUENCY.

Audio-Frequency Amplification. The use of one or more amplifying stages in the audio-frequency circuit or a wireless receiver or radio gramophone, sometimes combined in the latter case with *Negative Automatic Volume Control*.

Audio-Frequency Rediffusion. A form of *Wire Broadcasting* in which a programme is picked up from a wireless broadcasting station and supplied by wire circuits to subscribers' loudspeakers.

Audio-Frequency Telegraph System. See VOICE FREQUENCY TELEGRAPH SYSTEM.

Audio-Frequency Transformer. A transformer for use in audio-frequency circuits, e.g. a TELEPHONE TRANSFORMER or a (low frequency) INTERVALVE TRANSFORMER.

Audio-Frequency Wire Broadcasting. See AUDIO-FREQUENCY REDIFFUSION.

Audiometer. An instrument for testing the sensitivity of the ear to sounds of varying pitch, depending on a *thermionic oscillator* capable of a wide range of frequency and variable calibrated output.

Audion. The name given by L. de Forest to the early form of three electrode moderate vacuum *Thermionic Valve* used by him as a wireless detector and amplifier.

Aura. See BLUE GLOW.

Aurora Australis. See AURORA BOREALIS.

Aurora Borealis (or Northern Lights). The glow, sometimes amounting to a brilliant arch in the sky with flickering streamers, seen in the direction of the North Pole in northern latitudes, under certain conditions, due to electric discharges in the rarefied upper strata of the atmosphere at heights above 70 km., possibly caused by streams of electrons emitted by the sun towards the magnetic poles

of the earth causing dissociation of oxygen. The corresponding effect in the case of the South Pole is called *Aurora Australis*.

Austin Formula. The field strength in microvolts per metre at a distance D kilometre from a transmitting aerial of effective height h and wave-length λ and aerial current i equals

$$(120 \pi h i / \lambda D) e^{-0.0015 D \sqrt{\lambda}}$$

Auto-Capacitive Coupling. Coupling of two circuits by means of a capacitance common to both.

Auto-Condensation. A method of applying *Diathermy* in which the patient lies on an insulated slab and acts as the common electrode of two capacitors in series.

Auto-Condenser. An air-condenser fitted with a movable intermediate electrode from which a variable potential can be tapped off.

Auto-Converter (or *O.M.B. Converter*). A single commutator converter with separate poles and brushes for the dynamo and motor sides, acting as a continuous current transformer of variable voltage ratio. (Applied in an electric automobile system to regulate the voltage applied to the motors automatically in inverse proportion to the current taken, in order to limit the draught of power from the battery and to avoid waste of power in resistance. When used in this way it has been called an electric *Valve*.)

Autodial. An appliance enabling a subscriber to an automatic telephone exchange to call a limited number of habitual numbers by single pressure on a key which causes the required train of calling impulses to be sent.

Auto-Galvanic Corrosion. Corrosion of metals due to electrolytic action independently of an external source of e.m.f.

Auto-Electronic Effect. See SKOT EFFECT.

Autodyne (Wireless) **Transmission.** The arrangement of a *Thermionic Valve* transmitter with the inductances in the grid and plate circuits forming a common coil or *Autotransformer*. The term autodyne is also sometimes used for *Endodyne*.

Autodyne Reception. See **ENDODYNE RECEPTION**.

Auto-Heterodyne Reception. See **ENDODYNE RECEPTION**.

Auto-Inductive Coupling. Coupling of two circuits by means of an inductance common to both.

Auto-Manual Telephone System. See **SEMI-AUTOMATIC EXCHANGE** and **TELEPHONE SYSTEM**.

Automatic Acceleration. Controllers of electric locomotives, cars, etc., are said to be arranged for "automatic acceleration," when the starting resistances are cut out in progressive steps by automatic electromagnetic means as the speed of the motors, and their back e.m.f., rises, without further movement of the controller handle.

Automatic Arc Lamp. An arc lamp in which the striking of the arc and the feeding of the carbons together is effected by electromagnetic or other means without necessity for hand adjustment. Cf. **HAND REGULATED ARC LAMP**.

Automatic Arc Welding. *Arc Welding* processes in which the work forms one electrode and the other is mounted in a holder provided with mechanism whereby the length of an arc is maintained constant.

Automatic Circuit-Breaker. A *Circuit-breaker* controlled by the current, etc., thermally, electromagnetically, or otherwise, which opens the circuit when certain predetermined conditions have been realised. See **OVERLOAD**, **MINIMUM**, **REVERSE CURRENT** and **TIME LIMIT CIRCUIT-BREAKERS**.

Automatic Controller. A controller arranged to provide for *Automatic Acceleration*.

Automatic Cut-Out. A term sometimes applied to the smaller classes of *Automatic Circuit-breaker*.

Automatic Direction Finder. A development of the *Robinson Wireless Direction Finder*, in which the galvanometer is replaced by a relay system controlling a motor employed to rotate the direction-finding coils until a balance is obtained and thus to keep an indicator on the bearing required. See also

DIRECT READING DIRECTION FINDER.

Automatic Electric Lighting Plant. See **AUTOMATIC GENERATING PLANT**.

Automatic Fault Signalling. See **FAULT SIGNALLING NETWORKS**.

Automatic Field Suppressor. See **FIELD SUPPRESSOR**.

Automatic Gain Control. Control of the amplification factor of repeaters, amplifiers, etc., in line and wireless telephony upon the principle described under *Automatic Volume Control*.

Automatic Gate Lock (in Electric Lift Control). A lock to lift-gates which is released only when the car is at rest at the landing and the controller is in the off position.

Automatic Generating Plant. A small petrol-electric or other *Generating Set* in conjunction with a battery, equipped with switch gear controlled automatically by relays so that the engine is started up (by the dynamo acting temporarily as a motor) when the battery voltage falls below a certain value, and is stopped when it rises to a value corresponding to the battery being fully charged.

Automatic Interrupter. An interrupter like the ordinary *Trembler* or *Hammer Interrupter* of an *Induction Coil*, worked entirely by the current which it interrupts. Cf. **MOTOR DRIVEN INTERRUPTER**.

Automatic Lift Control. A system of control in which a single operation (by push button, or otherwise) directs the car to a particular landing and causes it to stop there without any further control operation.

Automatic Lift Control, Directional Collective, Group, Interceptive Collective and Selective Collective. See **DIRECTIONAL COLLECTIVE**, **AUTOMATIC LIFT CONTROL**, **GROUP AUTOMATIC LIFT CONTROL**, etc.

Automatic-Monitor. A relay-operated variable capacitor serving to keep the frequency of a portable wireless transmitter constant.

Automatic Reversible Battery Booster. See **REVERSIBLE BOOSTER**.

Automatic Ringing. The arrangement of telephone exchange

connections, whereby a called subscriber's bell rings automatically as soon as his line is connected, without the operator having to manipulate a special key.

Automatic Routiner. An apparatus used in automatic telephone exchanges for carrying out the sequence of operations required for routine tests automatically.

Automatic Scrutineer. An apparatus used in *machine telegraph systems* to indicate automatically when adjustment is required owing to inequality of the *marking* and *spacing currents* or if *phase-creep* is taking place.

Automatic Signalling. Systems of railway signalling, usually controlled electrically, in which the signals are automatically put at danger when a train is on the section of the line in question.

Automatic Starter. A motor starter in which the starting resistances are cut out in progressive steps by electromagnetic or other means as the speed of the motor rises without any further attention on the part of the operator. Cf. **AUTO-STARTER**.

Automatic Starting Resistor. A starting resistor with a negative temperature-resistance coefficient, the resistance of which automatically falls as it heats up.

Automatic Substation. A substation, such as one converting alternating current to direct current for railway working, controlled by automatic switchgear without the presence of an attendant, so that the converting plant is set going as soon as the voltage drop in the contact rail or line exceeds a certain amount or other conditions are realised, and stops it again when not required. Cf. **SEMI-AUTOMATIC SUBSTATION**.

Automatic Synchroniser. An apparatus which, by means of *Relays*, etc., connected to a form of *Synchroscope* automatically closes the switch connecting an alternator, etc., to the *Bus-Bars* when synchronism is attained.

Automatic Telephone System. A telephone system in which connections are made by automatic apparatus

in the exchange on the sending of certain signals from the subscriber's station by a *Calling Dial* or otherwise.

Automatic Telephone System: Betulander, Bypass, Common Control, Director, Lorimer, Panel, R6, Relay, Rotary, Siemens, Step-by-Step, Strowger and Western Electric. See **BETULANDER AUTOMATIC TELEPHONE SYSTEM**, **BYPATH TELEPHONE SYSTEM**, etc.

Automatic Traffic Signalling. The lighting up of appropriate traffic signal lamps automatically either to give definite time-intervals of priority to the different streams or traffic or worked in accordance with the approach of vehicles which actuate road contacts. See **ELECTROMATIC TRAFFIC SIGNALLING**.

Automatic Train Stop. A catch, electrically or electropneumatically worked in conjunction with automatic railway signals, which engages a trip cock on a train that passes it when the signal is at danger, and thereby applies the brakes, but moves out of the way when the signal indicates that the line is clear.

Automatic Transformer Switch. See **TRANSFORMER SWITCH**.

Automatic Transmission. Methods of sending telegraph messages in the *Morse Code*, etc., at speeds higher than would be possible by hand-worked keys, such as by passing a previously punched strip through a special piece of apparatus, e.g. *Wheatstone Automatic Telegraphy System*.

Automatic Trolley Reverser. An arrangement of the contact line of a tramway at terminal points whereby the trolley is automatically reversed on reversal of the direction of motion of the car, by running round two curves forming an apex at the side, causing it to arrive on the other line wire in the reverse position.

Automatic Variable Voltage Ratio Transformer. A transformer with *tap-changing* gear operated automatically by a voltage regulator to compensate for line drop.

Automatic Voltage Regulator. An

apparatus by which the excitation of generators is controlled automatically to give a constant voltage at all loads, or a voltage having a predetermined relation to the load. See **THRILL REGULATOR**, **THURY REGULATOR**, etc.

Automatic Volume Control (A.V.C.).

Control of the degree of amplification of a wireless receiver so that a constant output strength is maintained notwithstanding the variation in the strength of the received signals due to fading. This is done by applying a d.c. voltage obtained by a rectifier in the output circuit to a control grid in the amplifying valve. See also **DELAYED AUTOMATIC VOLUME CONTROL** and **NEGATIVE AUTOMATIC VOLUME CONTROL**.

Automatic Wireless Call Device. An apparatus for actuating a call bell on receipt of a special *Wireless Call Signal*, usually consisting of a relay for starting a selector mechanism which only permits of the bell circuit being closed when the signal impulses coincide with the sequence of closing of the selector contacts.

Automobile (Electrical). A vehicle for ordinary roads driven by electric motors deriving their energy from a battery carried on the vehicle. Cf. **PETROL-ELECTRIC TRACTION**.

Automobile Lighting. The lighting of the head, side, tail, interior and any other lamps on an automobile electrically; usually by metal filament lamps of low voltage (6-12 volts) supplied with current from an accumulator battery which is kept charged by a specially constructed dynamo driven by the engine whenever it is running, wound to give a nearly constant voltage over a considerable range of engine speed, and provided with an automatic cut-out which disconnects it from the battery when the speed falls below the speed required for charging, or with a free wheel arrangement allowing it to run light as a motor when this is the case. In some cases the head lamps are run direct from the dynamo. In some systems, the dynamo is

combined as one machine with the starting motor. See **SELF-STARTER**.

Auto-Motor Generator. A *Motor-Generator* for use as a continuous current transformer with both armatures connected in series so that the action is analogous to that of an *Auto-Transformer*.

Autophone. Abbreviation for *Automatic Telephone*.

Auto-Plant. See **AUTOMATIC GENERATING PLANT**.

Autoplex Reception. A system of wireless reception employing a single valve for detection and high and low-frequency amplification controlled by variometers in both plate and grid circuits.

Auto-Pneumatic Circuit-Breaker. A h.t. circuit-breaker without oil in which a jet of air is forced from an orifice in the centre of one contact by the action of a piston which moves with the contact.

Auto-Relay. A *Relay* controlling the *Auto-Switch* in high speed telegraph *Repeater Stations*.

Auto-Room. A *Switch-Room* in an *Automatic Telephone Exchange*.

Autoscrutineer. See **AUTOMATIC SCRUTINEER**.

Auto-Starter. See *Auto-Transformer Starter*. This abbreviation should be avoided owing to liability of confusion with *Automatic Starter*.

Auto-Switch. An electromagnetically actuated switch provided in intermediate telegraph repeating stations to keep certain connections, which are normally open, closed as long as a message is passing. The apparatus is purposely made sluggish in its action to avoid opening the circuit in the spaces between signals.

Auto-Synchronous Motor. A *Synchronous Motor* with winding arranged so that it can be started up as an *inverted induction motor* and allowed to pull itself into synchronism. Cf. **SYNCHRONOUS INDUCTION MOTOR**.

Auto-Transformer. A *Transformer* provided with only one winding, part of which forms the secondary, while the whole forms the primary, or *vice versa*.

Auto-Transformer, Earthing and Neutral. See **EARTHING AUTO-TRANSFORMER** and **NEUTRAL AUTO-TRANSFORMER**.

Auto-Transformer Starter. A starter for induction motors in which a reduced voltage, obtained from an *Auto-Transformer* is applied, in one or more steps, to the stator at starting. No rotor resistance or slip rings are then required. Also called **COMPENSATOR STARTER**.

Autovalve. A type of lightning arrester depending upon the use of a porous substance containing finely divided conducting material.

Auvert-Ferrand Permutator. See **PERMUTATOR**.

Auxiliary Anode. See *Grid* (of a *Thermionic Valve*).

Auxiliary Coil. An additional coil in motors, etc., for purposes of *Compensation*, etc.

Auxiliary Contact. An additional contact on a switch, etc.; usually renewable, which finally breaks the circuit after the main current carrying contacts have been separated, thus taking the arc.

Auxiliary Electrode (in an *Electrolytic Cell*). An internal intermediate electrode for purposes of voltage measurement.

Auxiliary Lift Motor. An additional motor used only for driving the lift at slow speeds.

Auxiliary Poles. See **COMMUTATING POLES**.

Auxiliary Spark-gap. A small spark-gap in series with the main spark-gap of a sparking-plug in electric ignition, either separate or forming part of the distributor; found to improve the quality and cer-

tainty of the spark, particularly when there is slight leakage in the high tension circuit.

Auxiliary Switch. A switch mechanically connected with a circuit-breaker, etc., to actuate some auxiliary apparatus when the main switch is opened or closed.

Auxiliary Winding. Any winding additional to the main winding for a subsidiary purpose, e.g. winding used only during starting on the stator of a *Single Phase Induction Motor*.

A.V.C. See **AUTOMATIC VOLUME CONTROL**.

Average Candle Power. See **MEAN SPHERICAL CANDLE POWER**.

Averaging Recorder. An energy meter provided with a pen arranged to be carried round with the movement and released and returned to zero at fixed intervals, having drawn a series of lines equal in length to the average power in the interval.

A.W.G. Abbreviation for *American Wire Gauge*.

"A"-Wire. The wire of a telephone line connected to the *"T"-wire* within the exchange.

Axial Ducts. The ventilating ducts in an armature, etc., which are parallel to the shaft.

Axis : Magnetic and Neutral. See **MAGNETIC AXIS** and **NEUTRAL AXIS**.

Axis of Commutation. See **DIAMETER OF COMMUTATION**.

Ayrton-Mather Galvanometer. A form of moving-coil permanent-magnet galvanometer, with no iron within the moving coil.

Azimuth Compass. A magnetic *Compass* fitted with sights for taking bearings.

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B. Symbol for *Magnetic Flux Density* and *Susceptance*: also for *Brightness*.

B.A. Ohm. or B.A. Unit. A unit of resistance agreed upon as a standard by the British Association in 1865, equal to 0.9866 *International Ohm*. Cf. *LEGAL OHM*.

B. and S. Wire Gauge. The "Brown and Sharps" or "American" Wire gauge used for copper wire sizes in America. The diameters form a geometrical series in which No. 0000 is 0.46 in. and No. 36 is 0.005 in. Wires of a particular denomination in B. and S. Gauge are slightly smaller than those of the same denomination in the *British Standard Wire Gauge*.

"B" Battery. A term used for a high tension battery, usually consisting of one or more blocks of a number of dry cells, used for the anode circuit of a *Thermionic Valve*. More commonly called *High Tension Battery*. Cf. "A" BATTERY.

Back (of a Brush). Properly the *Leaving Edge*, but often used for the *Entering Edge*.

Back Ampere-Turns (or demagnetising turns). The part of the armature ampere-turns which act in a direction contrary to the main excitation.

Back Contact Key. A signalling key with a contact worked by the back part of the key lever, behind the fulcrum, which keeps the receiving circuit closed when the key is not depressed.

Back Contact Spring (in Telephony). A spring which makes contact with a *Main Contact Spring* in the normal position.

Back E.M.F. An e.m.f. in a circuit due to some auxiliary cause in a direction contrary to the main e.m.f. such as that due to the rotation of a motor armature, the effect of polarisation in a primary

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cell, or the back e.m.f. of an arc. Also called *Counter E.M.F.*

Backfiring (of a Mercury Vapour Rectifier). Sudden failure of rectifier action due to an internal fault sometimes caused by excessive density of mercury vapour produced by overheating the cathode. Also called *arcing back*.

Back-Geared Motor. A motor provided with a geared countershaft for speed reduction mounted on its frame.

Back Pitch. The *Winding Pitch* at the end of an armature away from the commutator. Cf. *Front Pitch*.

Back-Plate Lamp-Holder. A *Lamp-Holder* on a circular base for screwing on to a flat surface.

Backward Lead or Shift (of brushes). Angular displacement of brushes from the neutral open circuit position in a direction contrary to that of the rotation of the commutator, as usually required for sparkless commutation in a motor. Cf. *Forward Lead*.

Baffle. A screen surrounding the vibrating surface in a loud speaker of the cone type to prevent air waves from the front affecting the air pressure at the back, resulting in better production of notes of low pitch.

Baily Furnace. A type of *Resistance Furnace* in which the resistance material consists of crushed coke packed between suitable carbon electrodes: used for heating and reheating ingots, bars, etc., in rolling mills and for annealing, etc.

Bain's Chemical Telegraph System. An early system of telegraphy in which the messages are recorded on a strip of paper chemically prepared with potassium iodide and starch, which assumes a bright violet colour when a signal current has passed through it.

Bakelite. A synthetic insulating material which can be moulded and machined or used in liquid form for impregnation, made from phenol and formal.

Balance : Ampere, Centi-ampere, Composite, Deci-ampere, Dekampere, Du Bois, Hecto-ampere, Induction, Kelvin, Kilo-ampere, Line, Thomson, and Torsion. See AMPERE BALANCE, CENTI-AMPERE BALANCE, etc.

Balanced Armature Loud Speaker. A loud speaker in which a pivoted armature connected to the cone or other diaphragm is surrounded by stationary coils between which it moves.

Balance Control. See TONE CONTROL.

Balanced Current (or Voltage). A term, used particularly in connection with *Interference* in communication circuits for currents (or voltages) the algebraic sum of which is zero. Cf. RESIDUAL CURRENT (or Voltage).

Balanced Load. A load in a three-wire system which is equally shared by the two sides, or, in a poly-phase system, where it is identical in the various phases as regards current and power factor. Cf. UNBALANCED LOAD, OUT OF BALANCE, etc.

Balanced Modulator. An arrangement of two sets of modulating apparatus partly in opposition in a wireless telephone transmitting apparatus so that oscillations of carrier frequency are balanced and eliminated and only the *Side Bands* of waves are transmitted. See also UPPER SIDE BAND.

Balanced Sea Earth. A *Sea Earth* in a submarine cable with the earthing core terminating in a length of considerable resistance, such as stranded manganin wire.

Balanced Three-Phase and Three-Wire Systems. See BALANCED LOAD.

Balancer. A motor generator, transformer, etc., used to maintain, automatically or otherwise, equality between the voltages on the two sides of a three-wire system.

Balancer : Alternating Current, Compensator, Direct Current, Static, and Steam. See ALTERNATING

CURRENT BALANCER, COMPENSATION BALANCER, etc.

Balancer-Booster. A balancer set having *Boosters* for compensating for feeder drop coupled to its shaft.

Balancer Field Rheostat. A *Rheostat* for controlling the fields of a direct current balancer in which the ends of the resistance are connected to the neutral terminals of the two shunt field coils and the neutral bar to the moving contact.

Balancer-Transformer. An auto-transformer connected across the outer conductors of an alternating current three-wire system with the neutral wire connected to an intermediate tapping.

Balancing Aerial. An auxiliary aerial, usually at right angles to the receiving aerial of a duplex wireless station (i.e. one for sending and receiving simultaneously), adjusted so as to balance the effect of signals transmitted from the same station and thus to prevent them affecting the receiving aerial.

Balancing Capacitance. See COUNTERPOISE.

Balancing Flux. Flux provided in a machine to compensate for unequal magnetic pull due to mechanical or magnetic asymmetry.

Balancing Machine. An apparatus for testing the mechanical balance of a rotating part of a machine such as the complete rotor of a turbo-alternator, in order to ascertain the magnitude and position of the balance weights required for correction.

Balancing Network. An *Artificial Line* used for balancing purposes.

Balancing Rings. See EQUALISING RINGS.

Ballast Resistance. (1) A steadying resistance used to limit variations of current in a circuit, such as the resistance used in series with an arc-lamp to secure stable conditions, or the resistance of iron wire in hydrogen of negative temperature coefficient used in series with the glower of a Nernst Lamp and for other similar purposes. (2) In *Track Circuit Signalling*, the leakage resistance across the ballast between the two track rails.

Ballast Tube. A term sometimes used for a ballast resistance of the bulb enclosed type.

Ball-Ended Magnet. A permanent magnet for experimental purposes, consisting of a steel wire with a steel ball attached to each end, giving a close approximation to the effect of a pole concentrated at a point.

Ballistic Circuit-Breaker. A form of very high speed *Circuit-Breaker* in which the fusing of a silver wire in a closed vessel produces an arc developing a gas pressure sufficient to shoot out a stopper from the vessel like a projectile, finally breaking the circuit under oil.

Ballistic Galvanometer. A galvanometer in which the moving system is of considerable moment of inertia and of low damping factor, so that it can be used to measure the total effect of a current impulse due to such a cause as the discharge of a condenser or the sudden change in the flux through a magnetic circuit, by reading the amplitude of the first swing instead of a steady deflection.

Ballistic Method. A method of testing involving the use of a ballistic galvanometer or similar instrument, such as the ballistic method of determining the permeability of magnetic material, in which the current impulse induced in the secondary winding on the specimen when a current producing a known field (H) is reversed in the primary is measured by the swing of a ballistic galvanometer, and the induction (B) is calculated therefrom.

Ball-Lighting. See GLOBULAR LIGHTING.

Band, Armature, Binding, Frequency, Side, and Wave. See ARMATURE BAND, BINDING BAND, etc.

Band Filter. See BAND-PASS FILTER.

Band Losses. The energy loss in a motor, dynamo, etc., due to currents induced in the *Armature Bands*.

Band-Pass Reception. See BAND-PASS TUNING.

Band-Pass Tuning. A term sometimes used for a system of tuning wireless receivers employing two similar

circuits coupled by a reactance arranged so that the coupling is constant over a large range of tuning. Cf. BAND-PASS FILTER.

Band-Pass Filter. A *Frequency Filter* which permits only the passage of oscillations between certain limits of frequency. Sometimes used to improve selectivity of wireless receivers.

Band-Rejection Filter. A *Frequency Filter* which opposes currents within a certain range of frequencies.

Bank. A number of similar pieces of apparatus connected in parallel and used like a single piece of apparatus are sometimes said to be "banked," e.g. a "bank" of transformers, or an artificial load formed by a "bank" of lamps. In automatic telephony, a set of rows or *Levels*, fixed contacts, usually forming *multiples* over which the *Wipers* move in a *Selector*.

Bank Cable (in Automatic Telephony). A multi-conductor cable connecting a *Bank* on a selector to a terminal rack.

Bank Wires (in Automatic Telephony). Wires connecting the respective contacts in the *Banks* in selectors in multiple.

Banked Winding. A method of winding inductance coils for wireless apparatus in which successive turns do not form a continuous layer but are "banked up" in groups to diminish *self-capacitance*.

Bar. See BUS-BAR.

Bar(s): Armature, Bus, Commutator, Equalising, Flinders, Omnibus, and Tie. See ARMATURE BARS, BUS-BARS, etc.

Bar and Yoke Method. A method of magnetic testing in which the specimen under test is in the form of a bar which is clamped into a yoke of comparatively large section, to form a return path of low reluctance to the lines of force. See also DOUBLE BAR and YOKE METHOD.

Bar Coupling Panel. Part of a switchboard where provision is made to connect or to separate different sections into which a system of bus-bars is divided as may be required.

Bar Magnet. A straight bar-shaped

magnet with the poles at the ends.

Cf. HOBAN-SHOW MAGNET.

Bar Suspension (of a Traction Motor).

See YOKES SUSPENSION.

Bar Winding. See BAR-WOUND ARMATURE.

Bare Carbons. Arc-lamp carbons not coated with copper as is sometimes done to improve their conductivity.

Bare Conductor. A conductor not covered with insulating material.

Bare Electrode (in Arc-Welding). A metal electrode without flux covering or core.

Barkehausen Effect. Certain slight discontinuities in the increase in magnetisation of ferro-magnetic substances in an increasing magnetic field due to re-orientation of the elementary magnetic constituent of the atoms.

Barlow's Wheel. A piece of apparatus designed in the early days of electromagnetism to demonstrate the forces exerted by a magnetic field on a conductor carrying a current, in which a star wheel dipping into mercury, so that a current can be passed along its rays in succession, is caused to rotate in a magnetic field. This apparatus was made before Faraday's discovery of the principle of the dynamo and is the prototype of the electric motor.

Barrel Plating. Electroplating of articles in a rotating container with suitable negative contacts.

Barrel Winding. An armature winding in which the end connections lie flat upon a cylindrical surface.

Barretter. (1) An instrument used in early wireless telegraphy systems, in which small current impulses are detected or measured by their heating effect in a fine wire, by observation of the change in resistance produced. (2) A *Ballast Resistance*.

Barrier. See ARC SHIELD.

Barrier Film Rectifier. A rectifier of the class in which a film of unilateral conductivity is in contact with metal or other normally conducting plates. The best-known example is the copper-oxide rectifier. Also called *Electron Rectifier*.

Barrier-Layer Photo-Electric Cell. See PHOTO-VOLTAIC CELL (Electron type).

Barring Motor. A motor which can be geared temporarily to a large machine to turn it round slowly into the most advantageous position for starting or for inspection.

Bar-Type Current Transformer. A current transformer in which the primary is a straight conductor, surrounded by an iron core carrying a secondary winding, e.g. a BUS-BAR TRANSFORMER.

Bar-Wound Armature. An armature in which the conductors in the slots consist of bars of rectangular section instead of wires.

Base, Valve. See VALVE BASE.

Basket Coil. A form of coil used in wireless telegraphy, etc., made by threading in and out of an odd number of pegs and stiffened after completion by impregnation with insulating material.

Basket Winding. See CHAIN WINDING.

Batten Lamp-Holder. See BACK-PLATE LAMP-HOLDER.

Battens. Fixed or hanging rows of incandescent lamps used in stage lighting.

Battery. The term "battery" has come to mean a group of a number of similar pieces of apparatus in a group, more particularly primary or secondary cells connected together in series parallel or otherwise, or a "battery" of condensers. It is however often used incorrectly for a single cell by which a current is produced as the result of chemical reactions, and even for a non-chemical source of e.m.f., such as a magneto generator for shot firing. (The term appears to be due to the analogy of a battery of artillery, although, in this sense, the word really refers to its purpose for bombardment rather than to the multiplicity of the guns.)

Battery: Accumulator, Buffer, Central, Common, Dry, Floating, Galvanic, Gas, Local, Magnetic, Microphone, Plate, Ringing, Sealed-in, Storage, Traction, Universal, Voltaic, and Wet. See ACCUMULATOR BATTERY, BUFFER BATTERY, etc.

Battery Booster. A variable voltage motor-generator set, automatically or hand regulated so as to supply the difference of voltage necessary to cause a charge to be given to a battery, when required by the condition of the load; or simply to provide the extra voltage necessary for the battery to be charged from a circuit normally of a voltage equal to the discharge voltage. See REVERSIBLE BOOSTER, MILKING BOOSTER, etc.

Battery Charging Booster. See BATTERY BOOSTER.

Battery Cut-Out. An appliance for automatically taking a battery out of the circuit should the voltage drop below the charging value; sometimes arranged to close the circuit again when the voltage has risen sufficiently.

Battery Dialling. A system of dialling in automatic telephony, employing break impulses in an earth return circuit and a battery at the distant station. Cf. LOOP DIALLING.

Battery Eliminator. An apparatus for enabling high (and sometimes also low) tension batteries to be dispensed with in wireless receiving sets by making connection through a *Smoother Circuit* and suitable resistances to d.c. electric-light mains or by means of a rectifier to a.c. mains. Also called a *Mains Unit*.

Battery Gauge. A portable voltmeter for ascertaining the condition of individual cells in a battery.

Battery Ignition. Electric ignition in internal combustion engines in which the current for the induction coil producing the spark is derived from a battery of primary or secondary cells.

Battery Lamp. (1) An incandescent lamp requiring only a low voltage, such as can be supplied by a few cells. (2) A portable lamp complete with battery.

Battery Meter. A meter arranged to integrate the charge and discharge of a battery in ampere-hours, either on two separate dials or with a single mechanism (or two connected together) on one dial, so as to read forward for charging and backward for discharging; with or without a compensating

device to allow for the battery losses, so that the proportion of the charge remaining in the battery at any time can be read off.

Battery Regulating Switch. A multiple-contact switch connected to a group of cells at the end of a battery to vary the number of cells in circuit.

Battery Regulator, Electrolytic. See ELECTROLYTIC BATTERY REGULATOR.

Battery Ringing. The ringing of telephone bells by current obtained from a battery.

Battery Spear. A spike for making contact between the leads of a battery testing voltmeter and the plates of an accumulator cell.

Battery Switch. See BATTERY REGULATING SWITCH.

Battery System, One Meter and Two Meter. See ONE-METER BATTERY SYSTEM and TWO-METER BATTERY SYSTEM.

Battery Traction. Electric traction on rails or road, in which power is derived from batteries carried on the vehicles.

Baud. The time interval occupied by the signal element in telegraphy, variable in number for different letters in the Morse Code but constant in the Baudôt and other five-unit codes. The signalling speed is defined as so many "bauds" per second.

Baudôt Multiplex (telegraph) System.

A *Multiplex* printing telegraph system in which several Baudôt instruments are worked at the same time over the same line by the use of synchronous revolving contact-makers.

Baudôt Printing Telegraph System.

A type printing telegraph system in which the depression of a distinctive combination of five keys (representing a letter) determines the direction of five successive current impulses in the line. These, by means of a revolving contact maker, cause the same combination to be reproduced by the armatures of five electromagnets in the receiving instrument, and these changes of position cause the required letter to be printed by mechanical means. Cf. MURRAY,

CREED, HUGHES and STELJES SYSTEMS.

Baur's Constant. The voltage required to cause a discharge through a sample of a given insulating material one millimetre in thickness.

Baur's Law (of dielectric strength). The breakdown voltage required to cause a discharge through a dielectric of given material is proportioned to the $2/3$ power of its thickness.

Bayonet-Cap (B.C.). The form of incandescent lamp cap with a brass collar, about $\frac{1}{2}$ in. diam., which engages in a *Bayonet Holder*. Cf. EDISON-SCREW CAP, CENTRAL CONTACT CAP, and BOTTOM-LOOP TERMINALS, etc.

Bayonet-Holder. The form of lamp holder commonly used in Great Britain, with two spring plungers which make contact with the terminal plates in the lamp cap, and cause the side pins to engage firmly in the upturned part of the J-shaped slots in the barrel of the holder, and to secure the lamp when it has been inserted and given a fraction of a turn to the right.

B.C. Lamp Cap. See BAYONET-CAP.

"B" Cord Circuit. A junction operator's *Cord Circuit*.

Beacon, Airway, Radio and Wireless. See AIRWAY BEACON, RADIO-BEACON, &c.

Beacon, Wireless. See WIRELESS BEACON.

Bead Lightning. An appearance resembling luminous beads a few feet apart, sometimes seen after a lightning flash.

Beads, Insulating. See INSULATING BEADS.

Beam, Wireless. See WIRELESS BEAM.

Beam (in a Cathode Ray Tube). See ELECTRON JET, and CATHODE RAY OSCILLOGRAPH.

Beam Aerial. An aerial for radiating a concentrated beam of nearly parallel waves or receiving such a beam from a particular direction.

Beam Aerial System. The whole combination of aerials, reflecting and tuning apparatus required to

project a concentrated wireless beam or to receive from a particular direction only.

Beam Array. See AERIAL ARRAY.

Beam Current. The current carried by the electron stream forming the *Beam* in a cathode-ray tube.

Beam Current Characteristic. A curve showing the relation between *beam current* and applied potential in a cathode ray tube.

Beam Receiving Aerial. A *Beam Aerial* used for receiving waves from a particular direction only.

Beam Reflector. The portion of a *Beam Aerial System* acting as a reflector for concentrating the waves, not connected to the transmitting or receiving apparatus.

Beam System of Wireless Telegraphy. A system of wireless telegraphy employing short waves, concentrated into a nearly parallel "beam" by parabolic reflectors or parallel wires or by specially constructed directional aeriels; suitable for long distances and requiring much less power than non-directive stations.

Beam Trap. An arrangement in a cathode ray oscillograph for deflecting the beam off the screen when not actually in use, to avoid fogging the plate.

Bead Protective System. A current balance protective system for alternators, etc., in which the currents in the leads to the two ends of each phase winding are balanced in a transformer so that a relay is actuated if they are unequal.

Bearer-Cable. The supporting cable from which the contact wire is hung in a *Catenary Suspension*.

Bearing, Magnetic. See MAGNETIC BEARING.

Beat. When wave motions, such as sound or electric waves, of nearly but not quite equal frequencies are superposed, a pulsation is caused by the alternate coincidence and opposition of the waves. These pulsations of "beats" have a frequency which becomes lower as the two original frequencies become nearer. See BEAT FREQUENCY, HETERODYNE RECEPTION, etc.

Beat Frequency. The frequency of the beats caused by the superposition of an auxiliary frequency slightly different from the original frequency, as in the *Endodyne* and *Heterodyne* systems of wireless reception.

Beat Reception. A system of enabling unmodulated continuous waves of the usual range of high frequency (*Radio-Frequency*) to produce, after suitable rectification, an audible effect in a telephone receiver by the superposition of oscillation of a nearly equal frequency so as to produce *Beats* of a frequency which affects the telephone (*Audio-Frequency*). See *ENDODYNE* and *HETERODYNE*.

Beat, Zero. See *ZERO BEAT*.

Bec Carcel. A French standard of light consisting of an argand colza lamp; equivalent to 9.6 *International Candles*.

Beck Arc-Lamp. An arc-lamp for naval search-light work, cinematograph purposes, etc., employing chemically prepared carbons, in which a particularly high current-density is rendered possible by special measures, including rotation of the carbons and the supply of hydrocarbon gas or vapour to the arc.

Becquerel Rays. The name originally given to the rays emitted by uranium salts, etc. (discovered by A. H. Becquerel, 1852-1908). More active sources have since been discovered and the rays have been divided into several classes. See *RADIO ACTIVITY*, α , β , γ and δ Rays, etc.

Bedding. A layer of soft jute, tape, etc., immediately under the armouring of an armoured cable.

Bega. A prefix meaning 10^9 times, i.e. a billion times according to French and American nomenclature, or a thousand million times according to English nomenclature.

Begohm. 10^9 ohms, i.e. a thousand Megohms.

Bel. A recently proposed international name for a telephone transmission unit equal to ten times the American "*Transmission Unit*" (T.U.). (Cf. *NÉPER*.)

Belin System (of *Phototelegraphy*).

The earlier systems under this name employed an original prepared in relief from a bichromated film over which passes a stylus connected to an apparatus resembling a microphone in construction which varies its resistance according to the range of movement of the stylus and therefore to the thickness of the film. This variation of resistance controls the line current. In later forms of the system a transparent original and a light sensitive cell are used. A delicate galvanometer in the receiving apparatus causes the deflection of a beam in accordance with the variations of the line current and thus regulates the amount of light falling upon the synchronously moving receiving film.

Bell (Electric). A bell struck by a hammer through the action of an electromagnet attracting an armature to which the hammer is attached; arranged either to give a single stroke, or to continue repeating the strokes by the automatic action of a *Trembler*, or by the supply of alternating or intermittent currents.

Bell : Call, End, Extension, Magneto, Night, Single-stroke, Submarine, Submarine Call, Trembler, and Wireless Call. See *CALL BELL*, *END BELL*, etc.

Bell Push. A *Push Button* used for ringing an electric bell.

Bell Receiver. The original form of electromagnetic telephone receiver invented by Graham Bell in 1876 in which a steel diaphragm is in the field of a permanent magnet the pull of which on the diaphragm is varied according to the wave form of the sounds to be reproduced by the superposition of a variable field due to the received telephone current which passes through a coil on the pull of the magnet. (The same instrument was also used as a transmitter, without any battery, as the movement of the diaphragm induced currents in the winding on the magnet pole.)

Bell System of Phototelegraphy. A system of *Phototelegraphy*, in use in America, in which a *Potassium*

Cell is placed within a transparent revolving drum carrying the photograph to be transmitted so that the beam of light passing through successive parts of the film falls directly on it. The modulations so produced are applied in the recording apparatus to an electromagnetic light relay.

Bell Telephone. See **BELL RECEIVER**.

Bell Transformer. A small transformer for working electric bells from an alternating current.

Bellini-Tosi System (Wireless). See **WIRELESS DIRECTION-FINDER**.

Belt (Electric). A belt purporting to contain a sufficient source of e.m.f. to produce curative currents through the body.

Belt Dispersion or Leakage (in Induction Motors, etc.). A leakage flux occurring in slip ring *Induction Motors* when a primary phase belt overlaps two secondary phase belts. Sometimes used to include all other forms of leakage in the air gap, such as *Zig-Zag Leakage*.

Bend. A short length of conduit tube bent to a moderate radius for connecting two lengths of conduit tube at an angle with each other. Cf. **ELBOW**.

Bend: Half Normal, Normal, and Sharp. See **HALF-NORMAL BEND**, **NORMAL BEND**, etc.

Berry Transformer Switch and System. See **SERIES TRANSFORMER SYSTEM**.

Beta (β) Particles. The negatively-charged particles, each consisting of a single *electron* projected in β rays. See α **PARTICLES**.

Beta (β) Rays. The most easily deflected (by a magnetic field) of the three kinds of rays given off by radio-active substances. They affect photographic plates and are more penetrating than α rays but less penetrating than γ rays. They consist of negatively charged β particles travelling with a speed comparable with but less than that of light, i.e. up to 295,000 Km. per second. Cf. α , γ and δ **RAYs**.

Beta (β) Ray Spectrum. A diagram showing by the position of lines the velocities of β rays emitted by a radio-active substance from observations of the relative extent

to which they are deflected by a magnetic field.

Bethenod-Latour Alternator. A high frequency alternator for wireless telegraphy consisting of a combination of several machines with their pole systems angularly displaced relatively to one another.

Betulander Automatic Telephone System. An automatic system of telephone exchange working of the successive electromechanical selector switch type. Cf. **RELAY SYSTEM**.

Bevelled Poles. Poles with the shoes bevelled or chamfered off at the tips to improve the distribution of flux.

Beverage Aerial. See **WAVE AERIAL**.

B-H Curve and Loop. See **MAGNETISATION CURVE** and **HYSTERESIS**.

B.H.P. Brake Horse-Power.

Bias, Grid. See **GRID BIAS**.

Bias Voltage. See **GRID BIAS**.

Biased Differential Protective System.

A feeder protection system with pilot wires carrying a current derived from current transformers at the two ends of the line and arranged in such a way that inequality between the currents supplied by these transformers upsets the balance of the relays and trips the circuit breakers. (Also known as McColl protective system.)

Biassing Transformer. A current transformer used in a *Biased Differential Protective System*.

Bi-Band Telephony. A system of carrier current telephony in which a different carrier frequency is employed for speed in each direction.

Bichromate Cell. A *Primary Cell*, originated by Poggendorf, having a zinc negative and one or more carbon positive electrodes, with an *Electrolyte* usually of dilute sulphuric acid with potassium bichromate as a *Depolariser*; either of the *Single Fluid* or *Double Fluid* type. See **BOTTLE BATTERY** and **FULLER CELL**.

Bifilar Suspension. A form of suspension for the moving systems of galvanometers, etc., consisting of two separate wires, fibres of quartz, etc., in which the raising

of the centre of gravity of the suspended system caused by the twisting of the wires out of the parallel position supplies practically the whole of the controlling force.

Bifilar Winding. A winding made *Non-Inductive* by winding two wires carrying current in opposite directions together side by side as one wire; used for resistance coils, etc.

Bifurcating Box. A cable dividing box for making a Y joint between a two core or a twin concentric cable and two single core cables. Cf. TRIFURCATING BOX.

Bigrid Valve. A *Thermionic Valve* with two grids, e.g. for combining function of two valves into one. Cf. SCREENED VALVE.

Billi. Prefix meaning a thousand millionth (10^{-9}), i.e. a billionth according to the French and American nomenclature. (In Great Britain, a billion is used to mean a million million (10^{12}).)

Billi Condenser. A tubular variable condenser capable of very fine adjustment.

Billohm. 10^{12} ohms. See also BILLI.

Bimetal Fuse. A fuse element of two different metals, e.g. a copper wire coated with lead.

Bimetallic Trip. Tripping gear of a circuit-breaker actuated by the deflection of a strip of two metals owing to their unequal expansion when heated by an excess current.

Bimetallic Wire. Wire composed of a central core of one metal, over which is electro-deposited a sheath of another metal, e.g. steel wire for use where better conductivity than that of a steel wire is required with considerable tensile strength, as in long overhead spans. Sometimes the copper coating is only protective. Such wire is also used for high frequency currents where the current is practically confined to the surface (see SKIN EFFECT), and by combining metals of positive and negative *Temperature Co-efficients* in proportions to give a temperature coefficient of zero.

Binary Converter. An apparatus for converting alternating into

direct current, being the equivalent of an induction motor-generator in a single machine. The stator carries both a three-phase winding and a d.c. exciting winding, and the rotor is provided with a d.c. commutator winding with three equi-potential points short-circuited.

Binder. See ARMATURE BAND.

Binding Band. See ARMATURE BAND.

Binding Post. A terminal, usually in the form of a pillar with a transverse hole to take the wire and a central clamping screw. This form of terminal is sometimes known as a "telephone terminal."

Binding Screw. A terminal, usually of the type described under *Binding Post* or of the pattern in which the wire, or an eye attached to it, surrounds a central screw, and is clamped between two nuts or a nut and a washer.

Binding Wire. (1) Wire of a high tensile strength for making *Armature Bands*. (2) See TIE-WIRE.

Binnacle. A fixed case containing a ship's compass and fitted with devices for approximately correcting errors due to the effect of the earth's field on the magnetic material in the ship's hull, etc.

Biotron. A combination of two *Thermionic Valves* connected to obtain a particularly steep characteristic.

Biphase. *Two-Phase*.

Bipolar. Having two poles, e.g. Bipolar Dynamo.

Bipolar Electrode. See SECONDARY ELECTRODE.

Bipolar Receiver. A telephone receiver with both poles of the magnet close to the diaphragm.

Birkeland and Eyde Furnace. An electric arc furnace for *Fixation of Nitrogen* with water-cooled copper electrodes, the arc between which is drawn out into a flat circular flame by electromagnets.

Birmingham Wire-Gauge (B.W.G.).

A gauge used in Great Britain for sheet metals and to a certain extent for wires. The wire diameters differ through most of the range only by a few per cent from the corresponding figures for the *British Standard Wire Gauge*. (The

Birmingham gauge for gold and silver is different.)

Bismuth Spiral Method (of Flux Measurement). Measurement of magnetic flux in an air gap, etc., by observing the change in resistance of a flat spiral of bismuth wire, which increases with increased strength of field.

Bisynchronous Motor. A motor of similar construction to a synchronous motor, which is run up to double synchronous speed by external means, and synchronised.

Bitumen Cable. Cable insulated with bitumen, a waterproof organic mineral substance of moderate strength, somewhat easily softened by heat. Such cables are usually armoured but not lead covered. Bitumen has the advantage over rubber of being ozone proof.

Bituminous Conduit. Conduit for underground cables made of a mixture of bitumen, sand, and other materials.

Blackening (of Incandescent Lamps). The black deposit which collects on the inside of the glass of incandescent lamp bulbs after a period of use, particularly if they have been run at too high a voltage, due to particles of the filament being shot off as it disintegrates. In the case of metal filament lamps, the effect can be lessened by painting the stem of the filament support with certain phosphorous compounds.

Blade (of a Switch). The moving part in knife and other types of switch which is forced into the contact jaws.

Blake Transmitter. An early form of *Telephone Transmitter* or *Microphone* in which a platinum bead made a varying contact with a carbon disc.

Blanket (Electric). A blanket having woven into it resistance wires by which a certain amount of warming effect can be procured by a current.

Blast Contacts. Contacts in a circuit-breaker provided with artificial acceleration of the gases of the arc by the forced flow of some fluid.

Blasting: (1) Electric. The firing of explosive charges electrically,

either by producing a spark within the fuse, which detonates the primer, or, more usually, by heating electrically a fine wire in the fuse. See *MINE EXPLODER*. (2) in Wireless Telegraphy. A particular form of jarring distortion obtained in loud speakers on the loudest notes when the valves of the set supplying them are overloaded, or when there is *Over-modulation*.

Blasting Cap. See *DETONATOR*.

Blasting Machine. See *MINE EXPLODER*.

Blattnerphone. A modern form of the *Telegraphone* of Poulsen in which sounds are recorded in the form of a change of the magnetisation along a steel strip. Used for recording and reproducing broadcast programmes and for sound film production.

Blavier's Test. A fault localisation test in which the resistances from core to earth r_1 and r_2 , with the far end free and well earthed respectively, are measured. Then, if l is the length, s the resistance per yard of cable, the distance of the fault is

$$[r_2 - \sqrt{(r_1 - r_2)(l - r_2)}] / s \text{ yards.}$$

Bleach, Electrolytic. See *ELECTROLYTIC BLEACH* and *BLEACHING*.

Blind Current. See *WATTLSS CURRENT*.

Blind Power. An expression proposed for the total *Reactive Volt-amperes* in a three-phase circuit.

Blind Spots. A popular term for localities where wireless signals from a certain source are exceptionally weak, although they are received more strongly at a greater distance.

Block, Terminal. See *TERMINAL BLOCK*.

Block Condenser. A non-variable condenser made up as a solid block.

Blocking Capacitor or Condenser. A small condenser placed in a wireless circuit where it is desired to allow high frequency oscillatory currents to pass but to prevent the transmission of steady currents or oscillatory currents of low frequency.

Blocking Oscillator. A form of oscillator used in connection with scanning in television in which a capacitor is charged through one impedance and discharged through another.

Blondel Arc-Lamp. A form of enclosed flame arc-lamp in which the fumes are made to condense in a separate chamber by special arrangements for their circulation.

Blondel Hysteresimeter. See Hysteresimeter.

Blondel Oscillograph. The original form of moving conductor reflecting Oscillograph afterwards perfected by Duddell.

Blow. A fuse is commonly said to "blow" when it breaks the circuit owing to the action of an excess current, particularly when the current is heavy and the action is violent.

Blowing Current. The value of the current at which a given *Fuse-Link* actually blows.

Blow-Out Coil. See MAGNETIC BLOW-OUT.

Blow-Out: Magnetic and Solenoid. See MAGNETIC BLOW-OUT and SOLENOID BLOW-OUT.

Blow-Pipe. (Electric). An electric arc between electrode in a holder for welding purposes, projected on to the work by the action of a magnetic field.

Blue Glow (or "Aur"). A blueish light due to gas ionisation, which appears in a thermionic valve when the vacuum is low, but may be present to a certain extent in a *Soft Valve* without harm.

Blue Magnetism. An old-fashioned name for the lines of force at the *South Pole* of a magnet.

Board: Cross-Connecting, Control, Distribution, Fuse, Switch, and Test. See CROSS-CONNECTING BOARD, CONTROL BOARD, etc.

Board of Trade Ohm. (B.o.T. Ohm.). Another name for the *International Ohm*.

Board of Trade Panel. The panel on a traction switchboard containing the recording and other instruments necessary to ascertain whether the Board of Trade requirements regarding earth con-

nections, leakage currents, voltage drop, etc., are being met.

Board of Trade Regulations. The rules laid down by the Board of Trade specifying limitations in working pressure, leakage currents, voltage drops, etc., and requiring other safety precautions in electric supply and traction systems.

Board of Trade Standards. The standards of electrical measurement at the laboratory of the Board of Trade.

Board of Trade Unit. The unit by which electrical energy is commonly sold by supply authorities in Great Britain, equivalent to one kilowatt-hour, 3,415 B.Th.U., 2.6552×10^6 ft.-lbs. or 36×10^5 joules; called by some writers the *kelvin*, commonly spoken of as a "Unit."

Bobbin. Properly the reel on which is wound a coil of insulated wire such as in the small electromagnets on electric bells, etc., but now sometimes used for electromagnet windings themselves, even up to the largest field coils in dynamos and motors. See SPOOL, and cf. FORMER.

Boiler (Electric). A boiler heated electrically by passing current either through resistances or through the water itself. Large boilers of the latter kind, heated by alternating currents, are employed to absorb surplus energy from water power stations.

Boiler, Electrode, and Water-jet. See ELECTRODE BOILER and WATER-JET BOILER.

Boiling Plate (Electric). An electrically-heated apparatus giving a sufficiently high temperature to boil water in a flat-bottomed vessel standing thereon. Cf. HOT PLATE.

Bogie: Motor and Trailing. See MOTOR BOGIE and TRAILING BOGIE.

Bolometer. An instrument in which radiant energy is measured by the alteration in resistance of a wire heated by its absorption.

Bond. A conductor, generally of copper, placed in parallel with a joint in a conductor to improve its conductivity, used principally in the case of rail bonds for *Conductor Rails* or track rails

carrying return current on electric railways, or of bonds to ensure electrical continuity of joints in cable armouring or other earthed metallic covering to electrical apparatus.

Bond: Cable, Chicago Rail, Conductor, Continuity Cable, Continuity Rail, Cross Rail and Cable, Impedance, Intertrack, Plastic, Reactance, and Track. See CABLE BOND, CHICAGO RAIL BOND, etc.

Bonding Clip. A clip used in wiring systems employing metal cased conductors for ensuring conductive continuity of the earthed sheath.

Bonding Ring. A suitably shaped ring used to connect the metal sheathing of conductors entering a junction box or a fitting in interior wiring systems.

Bone of Horus. Name used by the Ancient Egyptians for the lodestone or magnet (after Horus or Apollo).

Bonetti Machine. A variety of *Influence Machine*, differing from the better known *Wimshurst Machine* in being sectorless and in having a larger number of brushes at the ends of the neutralising rods.

Boom, Trolley. See TROLLEY BOOM.

Boost. The extra voltage supplied by a *Booster*. (Also as a verb, to supply extra voltage.)

Booster. An auxiliary generator, usually motor-driven, or a transformer, included in a circuit to give an increase or decrease of voltage, e.g. for battery charging or compensation for feeder drop; controlled automatically or by hand.

Booster: Automatic Reversible, Balancer, Battery-charging, Capacitance, Differential, Entz, Highfield, Lancashire, Milking, Negative, Reversible, Sucking, Traction, Track and Turnbull-McLeod, See AUTOMATIC REVERSIBLE BOOSTER, BALANCE-BOOSTER, etc.

Booster Transformer (or **Boosting Transformer**). A transformer with its secondary in series with the line for injecting a voltage to compensate for line drop on an a.c. feeder or for some other purpose.

Boots, Insulating. See INSULATING BOOTS.

Boric Acid Fuse. A fuse within a tube with a boric acid lining which gives off a vapour having a powerful extinguishing effect.

Bornite. See PERIKON DETECTOR.

B.o.T.Ohm. See BOARD OF TRADE OHM.

B.o.T. Unit. See BOARD OF TRADE UNIT.

Bottle Battery. An old-fashioned name given to a form of single fluid *Bichromate Cell* in a bottle-shaped glass vessel with two fixed carbon plates and a zinc plate between them, which can be drawn up out of the electrolyte into the neck of the bottle, when the cell is not in use, to avoid local action.

Bottom Loop Terminals. The terminals formed by the looped leading in wires of incandescent lamps with no terminal cap.

Boucherot Circuit. A circuit containing an arrangement of inductance and capacitance which permits of a constant current supply being taken from a constant voltage a.c. circuit.

Boucherot Motor. A form of induction motor taking a low starting current having a double rotor winding consisting of a non-inductive and an inductive winding in parallel, the effect of the latter being less as the speed rises and the secondary frequency diminishes.

Bougie Decimale. (Decimal Candle.) A French standard of luminous intensity, roughly one-twentieth of the *Violet Standard*, equivalent to the *International Candle* agreed upon later.

Bound Charge. The older textbooks speak of an induced charge as being "bound" when still in the presence of the charge of opposite sign that induced it. Cf. FREE CHARGE.

Bourne Circuit. A circuit for wireless reception employing a transformer to couple the aerial to the tuned grid circuit of the first valve, the primary and secondary being connected together at the earthed end.

Bow Collector. The curved bar form of current collector, used for

higher speeds and heavier currents than those for which the trolley wheel is suitable.

Bow Strip. The renewable curved bar, usually of aluminium, which is the part actually making contact with the line in a *Bow Collector*.

Bowden-Thomson Protective System.

An automatic feeder protection system employing special cables, with metal intercores and external sheaths, through which current flows to a tripping relay in case of a fault between core and sheath.

Bowstring Suspension. A system of trolley wire suspension in which a certain degree of flexibility is afforded by the use of a short span wire carried by the bracket arm.

Box: Accumulator, Bifurcating, Brush, Cable, Conduit, Connection, Displacement, Distribution, Dividing, Draw-in, Feeder, Fuse, Joint, Outlet, Resistance, Sealing, Section, Shunt, Starting, Terminal, Test and Trifurcating. See ACCUMULATOR BOX, BIFURCATING BOX, etc.

Boxed Contacts. Contacts in a circuit-breaker within an enclosure which restricts the expansion of gases formed by the arc, as in the *Explosion-pot* type.

Box-Frame Motor. An *Ironclad Motor* without a split frame, as in some traction motors.

Box-Type Brush-Holder. A holder for carbon brushes in which the carbon block forming the brush slides in a rectangular box, and is kept pressing on the commutator by a spring. Thus only the brush and no part of the holder, except the spring, rides up and down with the irregularities of the commutator, and the brush does not alter its angle as it is fed forward.

Box-Type Frame. A stator frame for machines of large diameter, of single or multiple box section.

Box-Type Negative (Accumulator) Plates. Negative plates made up of two lead grids riveted together, retaining the active material between them. Also called *Cage-type negative plates*.

Bracket Arm Suspension. See SIDE POLE SUSPENSION.

Brackets. Electric Light *Fittings* for fixing to a wall or other vertical surface.

Bragstad Converter. See MOTOR CONVERTER.

Braided Wire. See BRAIDING.

Braiding. An outer plaited covering of wire or fibrous material impregnated with insulating compound, for protective purposes on cables and wires.

Brake (Electric). An electrically actuated brake for tramway, railway, and other vehicles, or electric cranes, hoists, etc., or a brake for measuring horse-power, or for providing the controlling torque in meters, etc., by the action of eddy-currents or other electrical method. The term "Electric Brake" is sometimes limited to the cases where the braking effect is obtained by making a motor armature act temporarily as a generator, while a brake depending upon the pull of a separate electromagnet is called a "Magnetic Brake."

Brake Horse-Power (B.H.P.). The output of a motor, engine, etc., as measured on a testing brake on a pulley on its shaft, expressed in *Horse-Power*. Cf. E.H.P.

Brake: Disc, Dynamic, Eddy-Current, Electromagnetic, Electro-mechanical, Magnetic, Regenerative, Rheostatic, Slipper, Solenoid and Track. See DISC BRAKE, DYNAMIC BRAKE, etc.

Brake Magnet. Any magnet used to produce a braking effect, such as the permanent magnets which provide the controlling torque on certain types of meter by the reaction of eddy currents on a revolving disc, and the magnets used to hold off the brake in an electric crane, lift, etc., when current is on the motor. These, in the case of alternating currents, are often similar in construction to induction motors, but with a limited angular movement of the rotor.

Brake-Wheel Arc Lamp. A form of arc lamp in which the carbons are fed forward by releasing a brake electromagnetically as the current drops in value.

Braking Controller. A controller

making provision for electric braking without further switchgear.

Braking Controller: Potentiometer and Rheostatic. See **POTENTIOMETER BRAKING CONTROLLER** and **RHEOSTATIC BRAKING CONTROLLER**.

Braking Notches (or Positions). Positions of a traction or other controller which apply some form of electric brake.

Branch (of a Polyphase Circuit). See **PHASE (2)**.

Branch Circuit. A portion of a circuit the lead and return wires of which are branched off from a main circuit. Thus in a lighting installation, a pair of mains may run through all the floors of a building and a number of branch circuits may be taken off through distributing boards on each floor.

Branch Switch. A switch controlling a *Branch Circuit*.

Branch Switchboard. A switchboard controlling a portion of an installation.

Branching Jack. A *Jack* in which the normal circuit is not broken by the insertion of the plug.

Branly Tube. One of the earliest forms of *Coherer*, consisting of a glass tube containing metal filings with suitable electrodes.

Braun Tube. An early form of *Cathode Ray Oscillograph*.

Brazil Resistance. See **CARBON DUST RESISTANCE**.

Breadth Coefficient. A coefficient used in the design of alternators to allow for the presence of coils occupying a fraction of a pole pitch. See **PITCH COEFFICIENT**.

Break. (1) An interruption, accidental or otherwise, in an electric circuit. (2) The length of the space by which the contacts of a switch, circuit-breaker, etc., are separated when the switch, etc., is open. See **QUICK-BREAK SWITCH**, etc. (3) The apparatus used with *Induction Coils* for repeatedly making and breaking the primary circuit.

Break: Auxiliary, Hammer, Mercury, and Motor. See **AUXILIARY BREAK**, **HAMMER BREAK**, etc.

Break Impulse. An *Impulse* consisting of a brief cessation of current.

Break Jack. A *Jack* which breaks

the normal circuit when the plug is inserted.

Break Spark. The spark produced between two current-carrying contacts, when they are drawn apart, intentionally or by accident, to break a more or less inductive circuit. In the former case sometimes called a *Wipe Spark* and often partaking of the nature of a transient arc. Cf. **JUMP SPARK**.

Breakdown (of a Dielectric). The sudden passage of a discharge through a dielectric, when the e.m.f. applied is too great to be met by the elastic displacement of the electrons. Analogous to the mechanical yielding of a solid when the elastic limit is passed.

Breakdown Factor. The ratio of the load at which an induction motor falls out of step to its full load.

Breakdown Switch. A switch provided in some old three-wire systems to couple the outer conductors together so that a single dynamo could carry on the supply to both sides of the system.

Breakdown Voltage. See **DISRUPTIVE VOLTAGE**.

Breaker Controller or Starter. A controller or starter of the face plate, drum or other type in which interruption of the circuit is separately effected by an interlocked *Contact*.

Breaking Capacity. The maximum load in watts or amperes at which a *Circuit-Breaker* or switch can open the circuit without damage to itself under specified conditions.

Breaking Current. An expression used, in connection with the working of circuit-breakers, etc., for the r.m.s. (or d.c.) current at the moment of contact separation.

Breaking Down a Fault. Converting a high resistance fault into one of low resistance for easy localisation, by applying a voltage, equal to double the working voltage or more, to the section in question after it has been isolated from the rest of the system.

Breathing (of Insulation, etc.). The alternate drawing in and expulsion of air due to variations of temperature.

Breeze, Static. See **STATIC BREEZE**.
Bremer Arc Lamp. One of the earlier forms of inclined carbon flame arc lamp.

Bridge, (in). See **IN BRIDGE**.

Bridge: Alternating Current, Anderson's, Callendar Recording, Capacitance, Carey Foster, Conductivity, Dial-Pattern, Double, Heterodyne, Capacitance, Impedance, Kelvin, Kohlrausch, Limit, Magnetic, Metre, Miller, Permeability, Post Office, Raphael, Resistance, Selenium, Shering, Slide Wire, Thomson, Wheatstone's and Wien. See **ALTERNATING CURRENT BRIDGE**, **ANDERSON'S BRIDGE**, etc.

Bridge Duplex Telegraph System. A Duplex telegraph system in which the receiving instrument occupies the position of a galvanometer in a Wheatstone's Bridge, so that the outgoing current does not affect the home instrument although part of the line current flows through the distant receiving instrument.

Bridge Fuse. A fuse in which the fuse wire is carried in a holder engaging in spring contacts at both ends, so that it can be withdrawn to renew the fuse wire or to isolate the circuit.

Bridge Hanger. A type of Hanger consisting of an insulated bolt and clamp for use under bridges, in tunnels, carsheds, etc.

Bridge-Megger. An adaptation of the Megger insulation testing set to the measurement of moderate resistances by the addition of a resistance box, forming a Wheatstone's Bridge, and certain modifications in the connections, whereby the generator gives a lower voltage and the ohmmeter is used as a bridge galvanometer.

Bridge Transition. A method of connecting traction controllers so that motors can be changed from series to parallel and *vice-versa* without breaking the circuit by connecting the rheostats in parallel with the motors before the series connection is opened. Cf. **SHORT CIRCUIT TRANSITION**.

Bridging Condenser. A condenser of fixed value shunting a piece of apparatus to divert oscillations of the higher frequencies.

Bridging Telephone. A telephone receiver placed in parallel with another, or with some other apparatus in a telephone circuit. Cf. **IN BRIDGE**.

Bright Electro-plating. Electro-deposition of a bright coating of silver from a solution containing a small quantity of carbon disulphide.

Bright Emitter Valve. A Thermionic Valve with an ordinary tungsten filament in a vacuum with a gas pressure below 0.1 millionth of an atmosphere, which has to be raised to bright incandescence to give sufficient electronic emission. Cf. **DULL EMITTER**.

Brightness. The luminous intensity emitted by a surface in a particular direction per unit area projected in that direction. Symbol: *B*. See **LAMBERT**, **FOOT-LAMBERT**, **STILB** and **APOSTILB**.

Brightness, Intrinsic and Surface. See **INTRINSIC BRIGHTNESS** and **SURFACE BRIGHTNESS**.

Brilliance, Intrinsic. See **INTRINSIC BRILLIANCE**.

Britannia Joint. A method of jointing bare telegraph wires, etc., in which the ends are laid alongside each other with the tips slightly turned up (but not twisted together) and bound with fine tinned wire and soldered.

British Association Ohm and Unit. See **B.A. OHM**.

British Standard Candle. The standard of luminous intensity formerly used in Great Britain; being the light given by a sperm candle of specified dimensions, etc.; equivalent to 1.02 *International Candle*. See also **CARCEL**, **PENTANE** and **HEPNER LAMPS**, **VIOLIE STANDARD**, etc.

British Standard Wire Gauge (S.W.G.). The legal wire gauge generally used in Great Britain. The sizes run in more regular progression than in the Birmingham or American gauges, but do not differ very greatly. No. 1 is 0.300 in. diam., and No. 50 is 0.001 in. diam. The largest size is called 7/0 and is 0.500 in. diam.

Broadcasting. The transmission by "wireless" telephony (or telegraphy) of news or entertainment

items for reception by anyone provided with suitable receiving apparatus. In addition to the ordinary wireless method, systems are in operation utilising carrier current telephony superposed on the ordinary electric light mains.

Broadcasting Station (Wireless). A wireless transmitting station for the provision of a *Broadcasting* service, usually combined with special studios in the same or another building and connected to a system of land lines or cables over which the amplified modulations from distant microphones can be received.

Broca Galvanometer. An *Astatic Galvanometer* with two vertical oppositely magnetised needles, with consequent poles at their centres.

Brow Leakage. See **END LEAKAGE**.

Brown and Sharpe Wire Gauge. See **B. & S. WIRE GAUGE**.

Brown Detector. See **HOOPER-BROWN DETECTOR**.

Brown Submarine Relay. A submarine cable *Relay* in which a long light pointer attached to the moving coil bears lightly on and makes contact with one or other half of a rotating drum.

Brown Telephone Relay. An instrument for producing in a local current a magnified version of the variations of a weak telephone current by varying electromagnetically the length of a gap, minute enough to be conducting, between a point and a disc of metal. The adjustment of the gap is maintained automatically by the action of the local current.

Brush. A contact piece, of carbon or metal, caused by springs to press upon and to make contact with a rotating ring, disc, drum, etc., such as the surface of a dynamo commutator, slip rings, etc.

Brushes: Carbon, Compound, Copper, Exploring, Gauze, Graded, Graphite, Laminated, Negative, Pilot, Positive, Staggered, and Static. See **CARBON BRUSH**, **COMPOUND BRUSH**, etc.

Brush Arc-Lighter. An old form of *Open Coil* dynamo with a ring armature for running a large number of arc lamps in series.

Brush Arm. The radial portion of a *Brush Rocker* which carries one *Brush Spindle* in brush rockers supported from the bearings. Sometimes also used for *Brush Spindle*.

Brush Box. The chamber of rectangular section in which the carbon brush slides in a *Box Type Brush-Holder*.

Brush Contact, Inverted. See **INVERTED BRUSH CONTACT**.

Brush Contacts. Switch contacts made of laminations each of which can exert its own spring separately.

Brush Discharge. A form of discharge which takes place from a very highly charged conductor when no spark can pass, consisting of a pale bluish flickering brush of light accompanied by a cracking sound and slightly different in appearance in the case of positive and negative charges.

Brush Friction Loss. The energy loss in a machine due to the friction of the brushes on the commutator; proportional to the contact area and speed, but varying considerably according to the material of the brush and the condition of the commutator.

Brush Gear. All the fittings used for the support and adjustment of the brushes of a machine, etc.

Brush Heel. See **HEEL**.

Brush Holder. The device which holds the *Brush*, keeps it pressing on the commutator as it wears away and allows it the necessary freedom of radial movement.

Brush Holder: Box Type, Cartridge Type, Lever Type, Pneumatic Scissors Type and Reaction. See **BOX TYPE BRUSH HOLDER**, **CARTIDGE TYPE BRUSH HOLDER**, etc.

Brush Holder Arm. See **BRUSH SPINDLE**.

Brush Lead. Angular displacement of the brushes from the neutral position. See **BACKWARD LEAD** and **FORWARD LEAD**.

Brush Lifter. A device for permitting a single brush or a group of brushes on one brush arm to be lifted out of contact with the commutator; or, in the case of *Induction Motors*, to allow the brushes on the *Slip-Rings* to be

raised after the slip-rings have been short-circuited, when the machine has come up to its working speed.

Brush Resistance. The resistance of the actual material of the body of the brush added to the (much greater) contact resistance between it and the commutator. The resistance of the brush in a transverse direction from the leading to the trailing tip is also of importance in the obtaining of good commutation under difficult conditions and some brushes are purposely made with a higher transverse than longitudinal resistance.

Brush Ring. A ring in a large multipolar machine to which the whole of the brush gear is attached, so mounted that the whole of the brushes can be shifted in angular position on the commutator together. Usually limited to cases where it is supported from the field frame and not from the bearing pedestal.

Brush Rocker. The fitting upon which the brush spindles are mounted, arranged to have a certain amount of freedom of angular movement for adjusting the position of all the brushes simultaneously.

Brush Rocker Ring. See BRUSH RING.

Brush Shift. An expression sometimes preferred for *Brush Lead*.

Brush Shifting Control. The control of the voltage of a generator by shifting the position of the brushes, as in certain types of early arc lighting machines and in other constant current machines (see THURY SYSTEM); or the control of the speed of a motor by shifting its brushes, as in certain types of alternating current commutator motor. (See DICK MOTOR.)

Brush Shifting Device. Devices, automatic or otherwise, for varying the angle of lead of the brushes according to the load.

Brush Spindle. The spindle, insulated from the *Brush Rocker*, upon which all the *Brush-holders* of one set of brushes are mounted.

Brush Spring. A spring in a *Brush*

Holder which keeps the brush pressing against the commutator.

Brush Stud. See BRUSH SPINDLE.

Brush Yoke. A frame for supporting brush gear independently of the machine itself.

"B" Side (in Telegraphy). The single current circuits in quadruplex working.

Buchholz Protective Device (for Transformers). A device in which rise of the level of the oil, due to the evolution of gases caused by a fault, raises a float which closes a contact ringing an alarm bell. If the fault is severe, a second float is deflected by the rush of oil into the expansion vessel and the circuit-breaker is tripped.

Buchholz Protective System. A protective system for generators, etc., depending upon the formation of gaseous products when insulating materials are overheated, which affect the heat-transmitting power of the contents of a tube into which they are drawn. Rays from an incandescent lamp pass through such a tube and through a similar tube containing air on to nickel wires in two arms of a Wheatstone's Bridge, and any lack of balance between their temperatures cause a relay to be actuated.

Bucking Bar (in a High-speed Circuit-Breaker). A bar carrying the main current in the field of the holding on magnet to deflect the field on overload and cause the armature to be released.

Buckling (of Accumulator Plates). Distortion of the plates caused by unequal expansion due to overloading and other causes.

Buffer Battery. An *Accumulator Battery* arranged in parallel with a generating plant to equalise the load by assisting at times of heavy load and taking a charge at times of light load; often controlled automatically by a *Reversible Booster*.

Buffer Machine. A machine provided with a heavy flywheel which is allowed to slow down at times of heavy load and to give out energy to assist the generating plant and to speed up again at times of light load. See *FLYWHEEL SYSTEM*.

Buffer Resistance. See FIELD BREAKING RESISTANCE.

Buffer, Separator. See SEPARATOR BUFFER.

Buffer Transformer. See WILSON HIGH TENSION GENERATOR.

Buffer Valve. A *Thermionic Valve* used in a wireless receiver in an additional coupling stage between a tuned input circuit and a high-frequency amplifying valve to obtain stability by compensating the effect of input impedance of the amplifying valve.

Building Up. (1) A self-excited dynamo is said to "build up" as its voltage gradually increases from the small value due to residual magnetism to its full value, as the excitation rises with the rise of the voltage. (2) In Electrolysis: the deposition of a layer of metal upon parts of machinery to compensate for wear.

Bulb. The glass container of an incandescent lamp or thermionic valve. (Sometimes, but incorrectly, used for the whole lamp or valve.)

Bulb, Pipless. See PIPELESS BULB.

Bulk Supply. The supply of electrical energy from a generating station of a supply authority to a substation or distributing centre, from which it is distributed to individual consumers by a separate distributing authority.

Bulkhead Fitting. A flat circular cast-iron glass-covered fitting for mounting on ships' bulkheads and where space is limited.

Bunch Light. A portable group of incandescent lamps in a single reflector for stage or other localised lighting.

Bunched Cables. More than one cable run in one conduit, or, in telegraphy and telephony, several wires in parallel.

Bunched Conductors. A conductor composed of several wires twisted together in the same direction but not in regular layers.

Bunsen Battery. A collection of several *Bunsen Cells*.

Bunsen Cell. A *Primary Cell* of the double fluid type with zinc and carbon electrodes, an electrolyte

of dilute sulphuric acid and a depolariser of concentrated nitric acid.

Bunsen Photometer. See GREASE SPOT PHOTOMETER.

Burden. An expression preferred to *Load* for the output of the secondary side of an instrument transformer in volt-amperes, and sometimes used for the impedance of the instrument circuit to which it is designed to be connected.

Burglar Alarm. A system whereby the opening on a door, window, etc., or the treading on a section of the floor, causes an alarm bell to ring either by closing an electric circuit, or by interrupting a current normally flowing. In the latter case the bell also rings when the wire is cut or broken.

Buried Aerial. An "aerial" buried in the ground.

Buried Hearth Electrode Furnace. A *Direct Arc Furnace* with one electrode embedded in the hearth and covered with crushed carbon, e.g. *Tinfos* or *Lorenzen Furnace*.

Buried Wiring. *Interior Wiring* in which the conductors in the tubes, casings, etc., containing them are sunk in the walls, etc., out of sight. Cf. SURFACE WIRING.

Burn-Out. Serious damage to conductors, insulation, or both, caused by excessive current due to a short circuit, accidental arcing, etc., is often called a "burn-out"; also a fault consisting of a short circuit is said to "burn itself out" when the excessive current through it has fused the conducting path forming the short circuit.

Bus. Abbreviation for *Bus-Bar*.

Bus-Bar. The abbreviation commonly used for *Omnibus Bar*.

Bus-Bar(s): Feeder, Generator, Hospital, Reserve, Ring, Sectionalised, and Synchronising. See FEEDER BARS, GENERATOR BARS, etc.

Bus-Bar Sectionalising Switch. A Switch for separating a *Bus-Bar* into independent sections.

Bus-Bar Transformer. A *Current Transformer* of a type in which the core and secondary winding slips over a bus-bar or other straight conductor, so that the latter acts as the primary without alteration.

Bush. (1) In general: a lining, usually removable, to a hole, e.g. *Insulating Bush*. (2) of a Telephone Jack. The outer conducting tube of a jack ending in a ring in front of the board to which contact is made with the plug to make an *Engaged Test*. (Also called *Testing Bush*.)

Bush: Commutator, Insulating, Slip Ring, and Trolley. See COMMUTATOR BUSH, INSULATING BUSH, etc.

Bushing. Often used for *Bush*.

-bushing, Condenser-Type. See CONDENSER-TYPE BUSHING.

Bushing Current Transformer. A *Current Transformer*, built into the entry insulator of a high tension circuit-breaker with straight-through primary surrounded by a multilaminar secondary wound on a laminated iron ring.

Bushing Insulator. A tubular insulator for a high-tension conductor entering the case of a transformer or circuit-breaker or passing through a partition, etc., usually of porcelain with a ribbed exterior; sometimes with an air-space inside, and sometimes oil-filled or lined with other dielectrics. See also CONDENSER TYPE BUSHING and BUSHING CURRENT TRANSFORMER.

Bus-Line. An expression sometimes used for the cables connected by *Jumpers* and *Couplers* running along an electric train which have a similar function to the bus-bars on a switch board and connect the collecting shoes at various parts of the train.

Bus-Line Couplers. Plug and socket connectors between the coaches of an electric train, to connect the various control and other circuits running along the train.

Butterfly Connections. Strips in the form of a bent out fork used for armature end-connections.

Butt-Welded Joint. See BUTT WELDING.

Butt Welding. A resistance method of welding rods, etc., in which the flat ends of the rods to be welded are brought together without an overlap. Cf. SEAM WELDING and SPOT WELDING.

Button Switch. See PUSH BUTTON SWITCH.

Buzzer. An apparatus similar to an electric trembler bell without a gong, to produce a signal by a buzzing sound. A similar apparatus is used to produce slight oscillations for testing wireless receiving apparatus. Cf. RATTLER and HUMMER.

Buzzer Wavemeter. A wavemeter excited by a buzzer giving short trains of waves so that heterodyning is not necessary for detection.

Buzz-Stick. Colloquial name for an insulated and protected contact pole for testing the voltage across individual insulator units of a string under working conditions.

B.W.G. Birmingham Wire Gauge.

"B"-Wire. The wire of a telephone line connected to the *R-wire* inside the exchange. Cf. *A-wire*.

Bypass Automatic Telephone System. A development of the *Strowger System* in which a certain amount of common apparatus is substituted for individual apparatus during conversation for purposes of economy in plant.

By-pass. See SHUNT and BY-PASS SWITCH.

By-pass Condenser or Capacitor. See BRIDGING CONDENSER.

By-pass Switch. A switch sometimes provided in parallel with a large circuit-breaker which can carry the current while the circuit-breaker itself is withdrawn for inspection.

By-product Circuit. An unloaded *Phantom Circuit* not suitable for telephony, which is available for telegraphy.

C]

[Cab

C. Abbreviation for *Coulomb*. Symbol for *Capacitance* (formerly also for *Current*).

Cabin, Switch. See SWITCH CABIN.

Cable. A conductor for transmitting electric currents composed of several wires or strands laid up together, with or without insulating and protective coverings.

Cable: Aerial, Air-Space, Aluminium-Steel, Armoured, "Association," Atlantic, Bank, Bearer, Bitumen, Cab-Tyre, Coaxial, Composite, Concentric, Control, Deep Sea, Dry Core, Equalising, Feeder, Flat Twin, Flexible, Four Core, Gas Filled, Gas Pressure, Graded, Guide, "H," Hochstädter, India-Rubber, Insulated, Intermediate, Jute-Insulated, Krarup, Lead-Covered, Leader, Loaded, Multicore, Multiple-Twin, "Non-Association," Oil-Filled, Oilstatic, Oval, Paper-Insulated, Plain Lead-Covered, Pupinised, Quad, Rubber, Screened, Separately Lead-Covered, Served Lead-Covered, Pressure, Service, Shaft, Shore-End, Shot-Firing, Single, Single Core, "S.L.," "S.O.," Solid System of Laying, Split Conductor, Stranded, Submarine, Supertension, Taper-Loaded, Telegraph, Telephone, Three-Core, Trailing, Triple Concentric, Twin, Twin Concentric, Twin Flexible, Two-Core, Unarmoured, Underground, Varnished Cambric, and Vulcanised Bitumen. See AERIAL CABLE, AIR-SPACE CABLE, etc.

Cable and Bar Winding. An armature winding in which the conductors forming the upper layer are laminated to minimise eddy currents.

Cable Bonds. Connecting devices between the sheathing or armouring of two cables, or between the sheathing of a cable and earth to ensure continuity in the sheathing or its efficient connection to earth.

Cable Bonds: Continuity, Cross and Earthing. See CONTINUITY CABLE BOND, CROSS CABLE BOND, etc.

Cable Box. A box, usually of cast iron, into and out of which cables are led; containing a cable joint or joints; sometimes filled up with insulating compound.

Cable Charging Gear. Apparatus, such as a resistance which can be gradually cut out, special motor-generators or transformers, to apply the working pressure gradually to a cable having appreciable capacity in order to avoid the production of serious voltage surges.

Cable Core. That part of a cable consisting of one conductor and its insulation only. Several such cores may be laid up together in one cable. See TWO-CORE CABLE, THREE-CORE CABLE, etc.

Cable Coupling. A device for making a conducting joint between the conductors in cables to be joined, with or without an insulating sleeve.

Cable Detector, Electrode. See ELECTRODE CABLE DETECTOR.

Cable Drum. A large wooden drum on which a length of cable is coiled for transport.

Cable Drum Relay. See BROWN SUBMARINE RELAY.

Cable Ducts. Underground pipes (Single Ducts) or blocks with a number of tunnels or ways for the reception of cables.

Cable Ducts. Underground pipes or channels for the reception of cables.

Cable Fault. A break in a conductor in a cable or a failure of the insulation between two conductors or between conductor and earth. See LOCALISATION OF FAULTS.

Cable Gear. The complete equipment of steam haulage drums, brakes, etc., for hauling in and paying out submarine cable on a cable ship.

Cable Grip. A device which can be

- slipped over the end of a cable and, on being pulled, tightens itself and grips the cable so that it can be drawn into conduits, etc.
- Cable Joint.** A joint connecting two lengths of cable in which continuity of the conductor, the insulation, and the protective covering is maintained. See **JOINT BOX** and references under **JOINT**.
- Cable Relay.** A sensitive *Relay* used on submarine cable telegraph circuits. (See **BROWN RELAY**, **GULSTAD RELAY**, **DIPPER RELAY**, etc.)
- Cable Sheath.** See **CABLE SHEATHING**, **LEAD SHEATHING**, etc.
- Cable Sheath Bond.** See **CABLE BOND**.
- Cable Sheathing.** A protective covering of metal wire, bands, etc., on a cable. A term used particularly of submarine cables. See **ARMOURING**.
- Cable Ship.** A ship specially built or fitted for submarine cable laying or repairing.
- Cable Slings or Suspenders.** Loops of leather or other material used to attach an overhead cable to a supporting wire.
- Cable Socket.** See **SWEATING THIMBLE**.
- Cable Tank.** A large cylindrical tank at a cable factory, or on board a cable ship, in which cable is stored coiled up ready for paying out and can be tested under water.
- Cable Transformer.** An early type of transformer made in a cable machine by placing windings round a core of strands of iron wire.
- Cable Troughing.** An open channel for the reception of underground cables protected by a cover.
- Cable Wax.** A waxy substance found in cables after breakdown, due to chemical alteration of the insulating compound caused by ionization in voids in the insulation.
- "Cab-Tyre" Cable and Sheathing.** See **TOUGH RUBBER SHEATHING**.
- Cadence.** A signal in *Baudot* and other telegraph systems that conditions have been arrived at under which a key may be pressed.
- Cadmium Cell.** A standard cell giving an accurately known e.m.f. made up in an H-shaped glass container and having electrodes of mercury and a cadmium-mercury amalgam respectively, with a cadmium sulphate electrolyte and a depolariser of mercurous sulphate. See **WESTON NORMAL CELL**.
- Cadmium-Copper.** An alloy used for transmission lines of greatly better mechanical strength than copper, but considerably less conductivity.
- Cadmium Electrode.** A *Normal Electrode* used in accumulator testing made of metal cadmium.
- Cadmium Vapour Lamp.** A form of *Discharge Lamp* made both in the high pressure and low pressure forms, with a certain amount of cadmium vapour in the bulb giving a light mostly in the red and the green regions of the spectrum, intended for mixing with the light from mercury discharge lamp to obtain an approximation to daylight.
- Cesium Cell.** A *Photoelectric Cell* with a sensitive surface of the metal cesium, sensitive to the infra-red portion of the spectrum.
- Cage Aerial.** An aerial in which the component wires are parallel and form a "cage" of polygonal section.
- Cage Rotor.** See **SQUIRREL CAGE ROTOR**.
- Cage Type Negative Plate.** See **BOX TYPE NEGATIVE PLATE**.
- Calamine, Electrical.** Zinc silicate, so called on account of its *Pyroelectric* properties.
- Calcium Carbide Furnace.** An *Arc Furnace* for the manufacture of calcium carbide by heating a mixture of lime and coke.
- Calculagraph.** An instrument used in telephone exchanges to record the time of calls.
- Caldwell Interrupter.** An *Electrolytic Interrupter* similar to the *Wehnelt Interrupter* but with the platinum point electrode replaced by a lead rod in a porcelain tube pierced with small holes.
- Calibration.** A determination of the value of the scale readings of a measuring instrument by comparison with a standard instrument or otherwise.
- Calibration Error** (in *Marine Wireless Direction Finders*). The effect of

mutual induction between the fore and aft loop and the rigging of the ship, tending to crowd bearings in the neighbourhood of the bow or quarter towards the fore and aft line unless the fore and aft loop is made smaller than the athwartship loop or is loaded with inductance.

Callan Cell. A modification of the *Bunsen Cell* in which cast-iron replaced carbon for the positive electrode.

Calland Cell. A form of "Gravity" *Daniell Cell* with a copper cylinder at the bottom, and a zinc cylinder at the top, without any porous diaphragm to separate the copper sulphate from the zinc sulphate floating on it.

Callendar Recording Bridge. A form of Wheatstone slide wire bridge used for resistance thermometers and pyrometers in which the sliding contact is shifted automatically to the zero position by the current in the "Galvanometer" circuit, so that it can be used to move a recording pen on a resistance chart.

Call-Indicator. (1) An apparatus used in manual telephone exchanges linked up to automatic exchanges which translates the calling impulses from the latter into a visible signal. (2) a signalling device in an electric lift car indicating from which floor a call has been made.

Calling Dial. The apparatus, usually in the form of a rotatable dial attached to the subscribers instrument in an automatic telephone system which actuates a call by being set successively to the digits composing the number required.

Calling Device. A device used in automatic telephone systems for sending impulses to make a call, e.g. a *Calling Dial*.

Calling Lamp. A signal lamp on a telephone exchange switchboard, which indicates by its illumination that a call is being made. See *LINE LAMP* and *PILOT LAMP*.

Calling Party Release. A system whereby the switches, etc., making a connection in a telephone exchange are released for clearing the line automatically by a caller replacing his receiver.

Calling Plug. The plug used by the telephone exchange operator to make connection to the called subscriber's circuit.

Call-Meter. See *TELEPHONE-METER*.

Calomel Electrode. A *Normal Electrode* for testing purposes consisting of mercury in contact with calomel (HgCl) and potassium chloride solution.

Calorie. The quantity of heat required to raise the temperature of 1 gramme of water one degree Centigrade from fifteen degrees Centigrade: equivalent to 0.00396 British Thermal Units or 4.2 joules, also called *Small Calorie*, or *Gramme Calorie*. One thousand Calories is sometimes called a *Great Calorie*, *Large Calorie*, or *Kilocalorie*.

Calrod Heating Element. An element consisting of a coiled nichrome wire in a tube packed tight with manesium oxide for support and insulation.

Camera, Electron and Emitron. See *ELECTRON CAMERA* and *EMITRON CAMERA*.

Camshaft Controller. A form of traction controller, consisting of groups of separate switches mechanically actuated by cams.

Canal Rays. See *POSITIVE RAYS*.

Canal Traction. The various systems of electric working of canal-boats include the use of towing barges taking current from a contact line, tractors on rails or other tracks on the bank, and tractors running on overhead cable-ways, etc.

Candle (Electric). See *JABLOCHKOFF CANDLE*.

Candle: British Standard, Decimal, Hetner, International, Jablochkoff, Parliamentary, Standard, Standard Sperm. See *BRITISH STANDARD CANDLE*, *DECIMAL CANDLE*, etc.

Candle-Fittings. Electric light fittings, with special shaped incandescent lamps mounted on opal glass tubes in imitation of candles.

Candle-Foot. See *FOOT-CANDLE*.

Candle-Lamp. A small incandescent lamp with elongated bulb to imitate the flame of a candle, for use in candle fittings. Cf. *FLAME LAMPS*.

Candle-Metre. See *METRE-CANDLE*.

Candle-Power. The *Luminous Intensity* of a source of light in a

given direction measured in *International Candles*.

Candle-Power : Mean Conical, Mean Hemispherical, Mean Horizontal, Mean Spherical and Zonal. See MEAN CONICAL CANDLE-POWER, MEAN HEMISPHERICAL CANDLE-POWER, etc.

Canley Furnace. A form of *Crucible Furnace*.

Canopy-Switch. A circuit-breaker placed under the canopy over the driver of a trolley by which he can cut off the current in case of emergency; usually acting also as an automatic overload cut out.

Cap : Bayonet, Central Contact, Edison Screw, Insulator, Lamp, Protection, Small Bayonet, Small Central Contact, Vitrite. See BAYONET CAP, CENTRAL CONTACT CAP, etc.

Capacitance. The property which determines the magnitude of the *Charge* which is produced therein by unit potential. Symbol, *C*. The *Practical Unit* of capacity is the *Farad* (10^{-9} absolute C.G.S. electromagnetic units), but it is usually more convenient to make use of the *Microfarad* (one millionth of a farad).

Capacitance (or Capacity), Balancing, Distributed, Effective, Internal, Lower, Specific Inductive, Self and Stray. See BALANCING CAPACITANCE, DISTRIBUTED CAPACITANCE, etc.

Capacitance Area. See COUNTERPOISE.

Capacitance Booster. A device for raising the voltage of a line as the load increases, consisting of a series transformer, the secondary of which supplies a capacitor.

Capacitance Bridge. An arrangement analogous to the Wheatstone's Bridge for comparing capacitances in the various bridge arms; usually employing alternating or intermittent currents and a telephone in place of a galvanometer.

Capacitance Commutator. A revolving commutator for charging a capacitor and discharging it rapidly through a galvanometer over and over again for the measurement of capacitance.

Capacitance Coupling. The coupling of two circuits, particularly in wire-

less telegraphy, due to capacitance between points on them normally at different potentials. The *Coupling Factor* of the circuit of capacitances C_1 and C_2 of which C is common to both is $\sqrt{(C_1 C_2)/C}$. Cf. INDUCTIVE COUPLING.

Capacitance Current. The current which flows when an alternating voltage is applied to such a system as a cable, possessing considerable capacitance on open circuit. This current is, in phase, in advance of the voltage.

Capacitance Earth. See COUNTERPOISE.

Capacitance Magnifier. A *Magnifier* for cable signals in which deflection of a pallet attached to a moving coil affects the capacitance of the grid circuit of two oscillating valves, thus controlling the current in their output circuit.

Capacitance Reactance. The component of the reactance due to the effect of the capacitance; analogous but opposite in sign to the *Inductive Reactance*. Expressed in ohms by $1/2\pi fC$, where f is the frequency and C the capacitance (in farads). (Sometimes called *Condensance*.)

Capacitive Coupling. See CAPACITANCE COUPLING.

Capacitive Load. See LEADING LOAD.

Capacitor. Any system, possessing appreciable capacitance, i.e. in which an appreciable charge is produced by application of an e.m.f. If the e.m.f. is continuous, only a momentary rush of current will be produced (except for such small permanent current that there may be due to leakage), but if the e.m.f. is alternating, a current will surge in and out of the capacitance which will be in advance of the e.m.f. in *Phase*. Capacitors are therefore used to improve the power-factor of a system. Formerly more usually called *Condenser* or *Capacity*. See also *Condenser*.

Capacitor, Series and Synchronous. See SERIES CAPACITOR and SYNCHRONOUS CAPACITOR.

Capacitor Motor. (1) All induction motor for single-phase circuits which runs a two-phase motor with a condenser in series with one phase. (2) A type of compensated

polyphase induction motor in which a capacitor and a separate winding are employed for compensation.

Capacitor Transformer. An instrument transformer the primary of which carries the capacitance current through a capacitor connection over the high voltage to be measured.

Capacity. (1) The name formerly universal for what is now officially called *Capacitance*. (2) Of an *Accumulator Battery*. The quantity of electricity measured in ampere-hours which can be taken from a battery under working conditions at a given rate of discharge. See *DISCHARGE RATE*. (3) Of a *Generator, Central Station*, etc.: The output in kilowatts under ordinary full load conditions.

Capacity: Current Carrying and Plant. See *CURRENT CARRYING CAPACITY* and *PLANT CAPACITY*.

Capillary Detector. A detector of minute electrical impulses due to received electric waves, acting upon the same principle as the capillary electrometer. Also known as the *Armstrong-Orling Detector*.

Capillary Electrometer. A sensitive electrometer in which a displacement of a drop of dilute acid in a column of mercury in a capillary tube is produced by the action of an e.m.f. in changing the capillary forces due to surface tension, etc.

Capillary Lamp. A form of high efficiency *Mercury Discharge Lamp* with a tube of very small bore employing a high current density.

Capped End (of a Cable). See *SEALED END*.

Capping. The wooden strip cover to *Casing*.

Capitance. A term sometimes used for that part of the *Impedance* due to *Capacitance*.

Car (Electric). Any Railway, Tramway, or Road vehicle propelled electrically. See *ACCUMULATOR CAR*, *MOTOR-CAR*, etc.

Car: Accumulator, Gas-Electric, Motor, Petrol-Electric, Trailer, and Trolley. See *ACCUMULATOR CAR*, *GAS-ELECTRIC CAR*, etc.

Carbon(s): Arc Lamp, Bare, Coaxial,

Copper-Cored, Coppered, Cored, Flame, Flame-Cored, Flaming, Fluted, Impregnated, Inclined, Metal-Cored, Mineralised, Negative, Plain-Cored, Plated, Positive, Pure Solid, Solid, and Solid-Cored. See *ARC LAMP CARBONS*, *BARE CARBONS*, etc.

Carbon Arc. An arc between carbon electrodes, usually limited to pure carbons. Cf. *FLAME ARC*.

Carbon Arc Lamp. An arc lamp employing carbon electrodes, usually limited to those not employing flame carbons.

Carbon Arc Welding. *Arc Welding* employing an arc between carbon electrodes, filing metal being added if required.

Carbon Brushes. Brushes for *Commutators, Slip Rings*, etc., made of blocks of a special quality of carbon; giving better conditions of commutation than the metal brushes which they superseded.

Carbon Cell. A primary cell which converts the chemical energy of carbon into electrical energy.

Carbon Contact. An auxiliary contact on a switch, etc., for taking the arc on breaking the circuit, made of carbon.

Carbon Dust Resistance or Brazil Resistance. A resistance, chiefly used for earthing the neutral of three phase systems, made of carbon dust in zig-zag troughs.

Carbon Filament. The fine conductor of carbon which is electrically heated to incandescence in the vacuum (of about 30 millionths of a atmosphere) in the earlier form of incandescent lamp. Usually made by heating a cellulose filament made by the extrusion or "squirting" process. Cf. *METAL FILAMENT*.

Carbon (Filament) Lamp. An incandescent lamp with a carbon filament. (Introduced about 1870 practically simultaneously by Swan and Edison.)

Carbon Microphone. See *MICROPHONE*.

Carbon Regulator or Rheostat. A variable resistance consisting of a number of carbon plates which can be subjected to varying

mechanical pressure by a screw or otherwise.

Carbon Tetrachloride Fuse. A high-tension fuse immersed in carbon tetrachloride which has a powerful are extinguishing effect and is unflammable.

Carbon Transmitter. See MICROPHONE.

Carbonisation. The change in organic materials due to heat, which reduces them to carbon. Many insulating materials, when carbonised by overheating lose their insulating property.

Carbonised Cloth. A material, prepared by carbonising cloth in a vacuum, from which adjustable resistances can be constructed in the form of piled up discs subjected to varying compression.

Carcass. The complete field frame, poles, etc., of a dynamo or the assembled stator of an a.c. machine.

Carcel, Bec. See CARCEL LAMP.

Carcel Lamp. A French Photometric Standard consisting of a colza oil lamp giving under specified conditions a light equivalent to 9.6 International Candles. Originally intended to represent the twentieth part of the Violle Incandescent Platinum standard.

Card, Compass. See COMPASS CARD.

Cardew Earthing Device. An apparatus for putting a circuit to earth in case of abnormal pressure, depending upon the electrostatic attraction between an earthed metal plate and a light aluminium strip connected to the circuit. Cf. PARTRIDGE SAFETY DEVICE.

Cardew Voltmeter. An early form of voltmeter in which the needle was actuated by the expansion of a long wire of platinum alloy passing over pulleys. See HOT WIRE INSTRUMENTS.

Cardioid Diagram. See DIAGRAM OF RECEPTION.

Carey Foster Bridge. A form of slide-wire *Wheatstone's Bridge* arranged for the comparison of two nearly equal resistances of low value.

Car-Floor Contact. See FLOOR CONTACT.

Cargo Error (of the Compass). The

variation of the reading of the compass due to an alteration in the amount of magnetic material on board, as in the case of cable ships when a quantity of sheathed cable has been discharged from the tanks.

Carpet (Electric). A carpet having woven into it resistance wires by which a certain amount of heating effect can be produced by a current.

Carriage-Type Switchgear. Switchgear in which all the items belonging to one section or "panel" are mounted on a wheeled truck, so that they can be drawn forward clear of all live contacts for inspection and repair.

Carrier, Element and Plough. See ELEMENT CARRIER and PLOUGH CARRIER.

Carrier Current. A continuous or alternating current in a telephone circuit upon which the *Modulations* forming the actual message are superposed, e.g. the current from the battery in a microphone circuit. See also CARRIER WAVE TELEPHONY.

Carrier Current Telephony (and Telegraphy). See CARRIER WAVE TELEPHONY. See SIDE-BAND, UPPER SIDE-BAND, etc.

Carrier Frequency. The frequency of the *Carrier Wave* in wireless or superposed telephony or telegraphy.

Carrier Frequency Wire Broadcasting. A form of *Wire Broadcasting* in which the current distributed consists of a modulated current at a high carrier frequency, either transmitted on special circuits or superposed on circuits used as electric light mains or for other purposes. Cf. AUDIO-FREQUENCY REDUCTION.

Carrier System, Floating. See FLOATING CARRIER SYSTEM.

Carrier Telephony (and Telegraphy). See CARRIER WAVE TELEPHONY.

Carrier Wave. Continuous high frequency waves propagated either in space or along a circuit, upon which the audio-frequency *Modulations* corresponding to the voice waves are superposed. See also SIDE-UPPER BAND, SIDE-BAND and SUPPRESSED CARRIER WAVE.

Carrier Wave Telephony. Simultaneous transmission of several messages each employing a different carrier current of different frequency superposed upon a circuit used for other purposes, and modulated according to the telephone (or telegraph) signals, employing separate receivers for each message tuned to resonate to the individual frequencies of the separate messages. Special arrangements are employed including wave filters, etc., to eliminate the frequencies that are not within the ranges or "bands" actually required. For telegraphy on this system audio-frequencies are sometimes used, particularly on the Continent.

Carriers. The conductors fixed to the moving plates of *Influence Machines* which receive the induced charges and carry them to the main conductors. Cf. **FIELD PLATES**.

Carrying Capacity or Current. The current that a conductor or apparatus can carry without exceeding specified limits of heating or voltage drop.

Car-Shed Hanger. See **BRIDGE HANGER**.

Car-Switch (Lift) Control. A system of electric lift control from a switch or controller in the car. Cf. **ROPE CONTROL** and **PUSH BUTTON CONTROL**.

Cartridge Fuse. A fuse in which the *Fuse Link* is carried ready mounted in an enclosed or ventilated tube or plug, sometimes filled with arc-quenching material with suitable terminals so that it can be readily replaced; often made so that cartridges of different carrying capacities are not interchangeable.

Cartridge Type Brush Holder. A brush holder in which the carbon brush is held in a box of insulating material with a protective metal cover, from which it is fed out by a spring.

Cascade Amplifier. An *Amplifier* consisting of a number of *Thermionic Valves* in *Cascade Connection*.

Cascade Connection. Connection of similar pieces of apparatus together

so that the output side of each is connected to the input side of the next, as in the following cases: (1) Of *Condensers*, *Series Connection*. (2) Of *Induction Motors*. Connection of the *Stator* of a second motor to the *Rotor* of the first. Also called *Concatenation* or *Tandem connection*. (3) Of *Thermionic Valves*. Connection of a series of valves with the *Plate Circuit* of each coupled to the *Grid Circuit* of the next, to obtain several cumulative stages of *Amplification*.

Cascade Control. The method of obtaining a number of different economical running speeds with induction motors, i.e. speeds in which there is not a waste of power in regulating resistances, by combination of cascade connections. Used sometimes in combination with other methods such as *Pole Changing Control* in three-phase traction and propulsion of ships.

Cascade Converter. See **MOTOR-CONVERTER**.

Cascade Motor. A double motor in which the stator of one half can be connected to the rotor of the other to obtain a reduced speed, or a single motor in which the equivalent of cascade control is obtained by special arrangements of the stator or rotor windings.

Cascade Starter. A starter for making the necessary connections for putting motors in *Cascade Connection* for starting.

Cascade Synchronism. The synchronous speed of two motors connected in cascade.

Cascading Voltage. The minimum voltage which will cause discharge between adjacent units in a string of suspension insulators, usually less than the *Spark Over Voltage* for the whole string.

Cased Cord. A cable with a single layer of copper wires on a hemp core; used for inductances in wireless telegraphy.

Casing. Wooden strip with grooves to contain wires with a wooden *Capping* or cover; used for interior wiring of buildings also called *Moulding*.

Castellated Filament. A metal filament mounted in short zig-zags separated by horizontal portions as in some traction lamps (giving a reduction factor of about 0.93).

Castner-Kellner Process. An electrolytic process for the manufacture of caustic soda and chlorine, or chlorine compounds, by the electrolysis of salt. Metallic sodium is first produced as an amalgam with mercury electrodes, and is afterwards converted into caustic soda by contact with water.

Cataphoresis. *Electrophoresis* in which the particle in question passes towards the cathode. Cf. ANAPHORESIS.

Catch-Net. A wire network placed under high voltage transmission lines where they cross public roads, etc., or other overhead wires, for safety in case of breakage of the live wire.

Catelectrode. An old-fashioned expression for the negative pole of a battery. Cf. ANELECTRODE.

Catelectrotonus. The condition of increased irritability assumed by a nerve near the negative electrode, when a constant current is passed through it.

Catenary. See CATENARY WIRE.

Catenary Cross-Span Suspension. A form of *Cross-Span Suspension* of overhead contact lines in which *Catenary Suspension* is employed for the span wires.

Catenary Suspension. A method of suspending overhead contact lines for electric railways, etc., in which the difference of level of the wire due to sag is practically avoided by suspending the wire at frequent intervals by wires of different lengths from one or more bearer wires or cables.

Catenary Suspension: Compound, Double, Duplex, Indirect, Rigid, Simple, and Single. See COMPOUND CATENARY SUSPENSION, DOUBLE CATENARY SUSPENSION, etc.

Catenary Wire. A bearer wire in a *Catenary Suspension*.

Cat-fish, Electric See RAY.

Catharometer. An instrument for observing a change in the composition or speed of movement of the gases surrounding an electrically

heated wire by the change of resistance due to change of the rate of cooling.

Cathautograph. A system of transmission of visual writing in which a receiver similar to a *Cathode Ray Oscillograph* is used with a *fluorescent* screen on which writing caused by the moving "spot" remains visible for a short time. The transmitter contains a stylus regulating two resistances as in the *Telautograph* and thus controls the deflecting fields of the receiver.

Cathetron. A *Grid-Controlled Mercury-Vapour Rectifier* with the control electrode external to the tube.

Cathions. See CATIONS.

Cathode (also spelt *Kathode*). The pole or electrode through which according to the old convention the current leaves an electrolytic cell, vacuum tube or other piece of apparatus, i.e. the *Negative Pole*, and in a *Thermionic Valve*, etc., the electrode from which the electron stream is emitted. In the case of a primary cell, the electrode through which the current leaves the electrolyte, i.e. the copper, carbon, or other positive pole is sometimes called the cathode. (From Greek words, meaning literally the "way down.")

Cathode: Concave, Cold, Directly Heated, Hot, and Lime Spot. See CONCAVE CATHODE, COLD CATHODE, etc.

Cathode Dark Space. See CROOKES DARK SPACE.

Cathode Drop or Fall (of Potential). The concentration of potential gradient which occurs near the cathode in a highly exhausted vacuum tube, due to the higher speed of the negative ions or electrons than that of the positive ions. See GASEOUS DISCHARGE.

Cathode Filament. A filament forming the heated cathode in a *Thermionic Valve*, *Coolidge "X" Ray Tube* or other *Hot Cathode* tube or employed to heat the cathode indirectly.

Cathode Glow. A glow in the form of a velvety film, which appears on the surface of the cathode of a vacuum tube when the gas pressure

is reduced below about $1/2000$ of an atmosphere. Cf. *NEGATIVE GLOW*.

Cathode Oscillograph. See *CATHODE RAY OSCILLOGRAPH*.

Cathode Ray Direction Finder. A wireless receiving apparatus with two frame-aerials at right angles to each other, connected through amplifiers to the four plates of a *Cathode Ray Oscillograph*, the beam of which is so deflected as to show the direction of the received signal.

Cathode Ray Furnace. An experimental apparatus in which *Cathode Rays* from one or more concave electrodes are focused upon the object to be heated in a vacuum. A sufficiently high temperature can be obtained in this way to convert diamond into black carbon.

Cathode Ray Instruments. Measuring instrument, in which the indication is made by the movement of a beam of cathode rays falling on a fluorescent screen or photographic film, e.g. the *CATHODE RAY OSCILLOGRAPH*.

Cathode Ray Lamp. A vacuum tube in which *Cathode Rays* are directed onto a block of lime or similar material which becomes incandescent.

Cathode Ray Oscillograph. A cathode ray tube arranged with a fluorescent screen at one end upon which a narrow beam of cathode rays falls, and makes a visible spot of fluorescence. The beam is either in the field of two electromagnets, at right angles to one another and excited proportionally to the voltage and current in the circuit under investigation, or, more usually, passes two similarly crossed electrostatic fields. Owing to the deflection of the beam by these fields the spot is caused to execute energy curves corresponding to the circuit. The instrument can be used up to the very high frequencies employed in wireless telegraphy as a wattmeter, or for the study of wave-forms or phase differences. It can also be arranged for photographic recording. See also *ACCELERATION GRID*, *FOCUSING COIL*, and *ELECTROSTATIC*, *IONIC*, *MAGNETIC FOCUSING*, and *BEAM TRAP*.

Cathode Ray Particle. See *CATHODE RAYS* and *ELECTRON*.

Cathode Ray Pencil. A concentrated beam of *Cathode Rays*.

Cathode Ray Television Tube. A cathode ray tube used in a television receiver with a large fluorescent screen opposite the heated cathode upon which falls the sharply focused electron beam, modulated by the amplified incoming signals and deflected by a special set of electrodes in synchronism with the scanning beam in the transmitter. See also *KINESCOPE*, *ICONSOCOP* and *VARIABLE SPEED SCANNING*.

Cathode Ray Tube. A *Gas Discharge Tube* suitable for the production of *Cathode Ray*.

Cathode Rays. Rays consisting of a stream of negatively charged particles or *Electrons* given off from the cathode in a highly exhausted tube, i.e. when the gas pressure is reduced below $1/100,000$ of an atmosphere. They are deflected by a magnetic field, cause phosphorescence of glass, heat and exert mechanical force upon bodies on which they fall, and cause such a target or *Anticathode* within the tube to emit "*X*" Rays.

Cathode Spot. The bright spot on the surface of the cathode of a mercury vapour arc where the action is concentrated, resulting in a very high current density.

Cathode Sputtering. A method of depositing metal on a surface in a special low-pressure vessel with parallel plate electrodes, the cathode being of the material to be deposited on the anode by the ionic stream. A pressure of at least 1000 volts is required.

Cathode Stream. The stream of ions or electrons, i.e. "*Cathode Rays*," projected from the cathode in a *Thermionic Valve*, "*X*" Ray Tube, or other *Cathode Ray Tube*.

Cathodic. See *ELECTROPOSITIVE*.

Cathodic Protection. Protection of underground pipes, cables, etc., from corrosion by electrolysis due to tramway return currents, by bonding to the negative pole of the system.

Cathodophone. A form of microphone in which the heated cathode causes ionisation of the air between it and a suitably placed anode at a high difference of potential from it. The movement of the diaphragm causes pulsation in the ionic stream resulting in modulation of the current. The apparatus is used in one system of sound films.

Catholyte. The part of the *Electrolyte* in an *Electrolytic Cell* in close proximity to the *Cathode*. Cf. *ANOLYTE*.

Cations (also spelt *Cathion*, *Kathion* and *Kation*). The dissociated parts of molecules (or *Ions*) carrying positive charges which during electrolysis move towards the *Cathode*. Cf. *ANIONS*.

Cathin Type Valve. A *Thermionic Valve* in which a metal envelope, also forming the anode, is used.

Catolyte. See *Catholyte*.

Cat-Whisker. The fine wire which makes contact with the crystal in the most common form of *Crystal detector*.

Cautery Apparatus. Apparatus for performing surgical operations by means of an electrically heated wire.

Cavendish Experiment. A historic experiment of H. Cavendish (1731-1810) in which a charged sphere was enveloped by two insulated hemispheres. These, if they touched the sphere, received the whole of its charge leaving it discharged when removed; showing that all charges reside on the surfaces of conductors.

C.B. The usual abbreviation for *Central Battery*.

"C" Battery. An expression used for a *Grid Bias Battery*.

C.C. Lamp Cap. See *CENTRAL CONTACT LAMP CAP.*

Ceiling Plate. A metal plate for fixing on a ceiling with a cord grip or other attachment for a flexible cord to which connection is made behind the plate with or without other provision for supporting a pendant fitting.

Ceiling Rose. A fitting with a detachable cover, often of porcelain, and with terminals for the attach-

ment of flexible wire carrying electric light pendants.

Ceiling Switch. A switch for mounting on the ceiling to be actuated by a cord.

Cell. (1) A combination of electrodes of dissimilar materials and an electrolyte either capable of giving an e.m.f. owing to chemical action, as in a primary cell, or of producing a certain chemical action when supplied with current, as in an electrolytic cell, or both, as in an accumulator cell. (2) A cubicle or chamber for the accommodation of an item of high voltage switchgear. (3) The insulating tube which lines the slot and projects a little way from the end thereof in high tension armature windings, etc. (4) Any arrangement of electrodes between which is a substance subject to a change of electrical properties on a change of other conditions or vice versa. E.g. *Selenium Cell*, *Kerr Cell*, etc.

Cell: Accumulator, Agglomerate, Alkaline, Allan, Bichromate, Bunsen, Cadmium, Callan, Callaud, Carbon, Chloride of Silver, Clark, Codd, Concentration, Counter E.M.F., Daniell, Darimont, de la Rue, Double Fluid, Dry, Edison, Electrolytic, Electronic, End, Faraday, Fuller, Gravity, Helleisen, Hibbert, Inert, Karolus, Kerr, Knowles, Lalande, Lead, Leclanché, Light-Sensitive, Light-Voltaic, Meidinger, Photo-chemical, Photo-conductive, Photo-electric, Photo-electrolytic, Photo-emissive, Photo-voltaic, Photronic, Pilot, Poggen-dorf, Porous, Potassium, Primary, Regenerative, Regulating, Rectifier, Reversible, Schanshieff, Secondary, Selenium, Single Fluid, Skrivanoff, Smee, Standard, Storage, Thaloïde, Voltaic, Weston, and Wet. See ACCUMULATOR CELL, AGGLOMERATE CELL, etc.

Cell Constant. The ratio of the mean distance apart of the electrodes in a cell to the mean cross section of the current path.

Cell Inspection Lamp. A narrow incandescent lamp with a long thin oblong holder, which can be

introduced between the plates of an accumulator for examination.

Cell Tester. A portable voltmeter for testing the condition of individual cells of an ACCUMULATOR BATTERY.

Cellular Conductor. A stranded conductor for E.H.T. Transmission Lines composed partly of copper wires and partly of aluminium bronze hollow tubes.

Cellular Switchboard and Switchgear. Switchgear in which conductors belonging to different circuits or parts of circuits are kept in cells separated by fireproof partitions.

Cellulophone. A proposed electrical musical instrument in which the sound is produced in a loud speaker by the undulatory current passing through a photoelectric cell under intermittent illumination by a beam interrupted by a rotating perforated disc.

Cement, Electro. See ELECTRO-CEMENT.

Centi. Prefix signifying one hundredth.

Centi-Ampere Balance. A Kelvin *Current Balance* with a maximum range from 0.01 ampere to 1 ampere.

Centimetre. A name sometimes used for the C.G.S. electrostatic unit of capacitance and for the electromagnetic unit of inductance on account of the *Dimension* of both these quantities being length if K and μ are neglected. This practice is not to be recommended.

Central Battery Signalling. The provision of current for signalling purposes on a telephone system from a battery at the exchange.

Central Battery Telephone (or Telegraph) System. A system of working in which current for all purposes is supplied from a battery at the exchange (or central office) instead of employing local batteries for every microphone or instrument. (Also called *Common Battery System*.) Cf. LOCAL BATTERY SYSTEM.

Central Bracket Suspension. See CENTRE POLE SUSPENSION.

Central Contact Cap. A lamp cap of similar construction to the *Bayonet Cap*, but with the cap itself forming one terminal and a single contact plate the other.

Central Contact Lamp Holder. A *Lamp Holder* with one central spring contact, the brass collar forming the other.

Central Office. A term used in America for a Telephone Exchange, but more commonly limited in Great Britain to a telegraph office connected to a considerable number of lines.

Central Station. An establishment containing *Generating Plant* driven by steam or other motive power, for the public supply of electricity over a certain area. (Also called *Electricity Works*, *Generating Station* and *Power House*.)

Centre, Distributing. See DISTRIBUTING CENTRE.

Centre Pole Suspension. The suspension of an overhead tramway contact line from bracket arms carried on poles in the centre of the road.

Centre Slot System. The form of the conduit system of electric traction in which the slot is centrally placed between the rails. Cf. SIDE SLOT.

Centre Zero Instruments. Polarised indicating instruments capable of reading positive and negative values on both sides respectively of a zero in the centre of the scale.

Centrifugal Coupling. A coupling which engages by centrifugal action when a certain speed has been reached; used to enable motors of low starting torque such as single phase induction motors, to start and to run up to speed unloaded.

Centrifugal Starter. A device used on moderate sized induction motors in which a centrifugal governor arrangement causes a rotor resistance within the rotor to be short-circuited when the working speed has been reached.

Ceramic Insulators. Insulators made of porcelain or other vitrified material of the same class, such as those used for high tension transmission lines. See PIN TYPE and SUSPENSION INSULATORS.

C.G.S. Units. The system of absolute electrical units adopted by the British Association in 1873, based on the Centimetre, the Gramme

and the Second. Two of these systems have been developed depending respectively upon *Electrostatic* and *Electromagnetic* relations. The *Practical Units* in common use are derived from the latter. See also *M.K.S. SYSTEM*.

Chain Insulator. See *SUSPENSION INSULATOR*.

Chain Winding. A *Two-Range* three-phase winding with interlinked coils. (Also called *Basket Winding*.)

Chamber, Intake and Ionisation. See *INTAKE CHAMBER and IONISATION CHAMBER*.

Chamberlain and Hookham Meter. See *MERCURY MOTOR METER*.

Change Coil Instruments. Measuring instruments of the moving iron type with alternative replaceable coils giving a number of different ranges.

Change-Over Switch. (1) A switch with one set of moving contacts and more than one set of fixed contacts, which can be used to connect either of two circuits to a source of supply or either of two sources of supply to a circuit. (2) A switch for rapidly substituting one system of connections for another.

Change-Pole Motor. A *Multispeed Motor* for *Pole Changing Control*.

Change-Speed Motor. A motor which can be run at any one of a number of alternative economical speeds, e.g. by *Pole-Changing*, *Star-Delta*, or *Series-Parallel* connections. Cf. *VARIABLE SPEED MOTOR*.

Changer, Pole. See *POLE CHANGER*.

Channel, Communication. See *COMMUNICATION CHANNEL*.

Channel Working (in Cable Telegraphy). The use of one cable circuit as two channels by sending signals from two sources in rapid succession alternately and separating them by synchronous apparatus.

Characteristic. See *CHARACTERISTIC CURVE*.

Characteristic : Anode-Current. Dynamic, External, Falling, Full-Load, Grid-Current, Internal, Line, Lumped, No-Load, Open-Circuit, Series, Short-Circuit, Shunt, Speed-Torque, Static, and Total. See *ANODE CURRENT CHARACTERISTIC, DYNAMIC CHARACTERISTIC*, etc.

Characteristic Curve. Any curve

exhibiting the relation between interdependent properties of a piece of apparatus, such as e.m.f. and Current.

Characteristic Impedance. The limit to which the impedance of a telegraph or telephone line approximates as its length is indefinitely increased.

Characteristic Radiation. The "X" Rays of particular frequency emitted by a substance as *Secondary Radiation* when bombarded by "X" Rays of sufficiently high frequency; sometimes called *Fluorescent "X" Rays*. It is found that the square roots of the frequencies of the rays given out by the elements form a series corresponding to their *Atomic Numbers*.

Characteristic Surface (of a Thermionic Valve). A surface connecting coordinates representing simultaneous values of three variables, such as anode or grid voltages or currents. See *ANODE CURRENT SURFACE and GRID CURRENT SURFACE*.

Characteristic "X" Rays. See *CHARACTERISTIC RADIATION*.

Characteristic "X" Ray Spectrum. The spectrum of the *Characteristic Radiation* of a particular substance.

Charge. (1) The quantity of electricity contained by a conductor, i.e. the degree of excess or deficiency of electrons. (See also *Unit Charge*.) By analogy the distribution of magnetism on a magnet is sometimes spoken of as a charge of magnetism. (2) The passage of a current through an accumulator in the direction which causes the chemical changes effecting a storage of energy therein. (3) The number of ampere-hours passed in this way. (4) Used as a verb, to impart a "charge."

Charge: Bound, Density of, Dissipation of, Electrostatic, Free, Induced, Loss of, Negative, Positive, Residual, Space, Static, and Unit. See *BOUND CHARGE, DENSITY OF CHARGE*, etc.

Charge and Discharge Key. A highly insulated key for telegraph purposes with three positions which charge, insulate, and discharge the line respectively.

Charge Indicator. See **POTENTIAL INDICATOR.**

Charge of Magnetism. See **CHARGE.**

Charger, Trickle. See **TRICKLE CHARGER.**

Charger and Replenisher. See **Replenisher.**

Charging, Roundabout Method of. See **ROUNDABOUT METHOD OF CHARGING.**

Charging Current. (1) The proper current strength at which a particular accumulator should be charged. (2) A current in the direction that will charge an accumulator. (3) A current flowing into a condenser.

Charging Current, Anomalous and Normal. See **ANOMALOUS CHARGING CURRENT** and **NORMAL CHARGING CURRENT.**

Charging Gear, Cable. See **CABLE CHARGING GEAR.**

Charging Resistor. See **CABLE CHARGING GEAR.**

Charging Voltage. The voltage required to pass the proper charging current through an accumulator battery, varying up to nearly 3.5 volt per cell.

Chariot. The arm, rotating in synchronism with the type wheel in the Hughes printing telegraph which is tripped by one of a circle of pins at the moment during its rotation corresponding to a particular letter.

Chart, Magnetic. See **MAGNETIC CHART.**

Chartered Electrical Engineer. A Member (M.I.E.E.) or an Associate Member (A.M.I.E.E.) of the Institution of Electrical Engineers, London.

Chart-Recording Instruments. See **GRAPHIC INSTRUMENTS.**

Chatterton's Compound. An adhesive insulating material softened by moderate heat.

Cheek Receiver. A receiver in the control room of a Broadcasting Station by which the quality of the transmission can be gauged for regulating purposes.

Cheek-Type Frame. A stator frame with deep end shields and fixed on removable flanges to hold the core plates.

Chemical Telegraph, Bain's. See **BAIN'S CHEMICAL TELEGRAPH.**

Cherix Modulator. A system of

modulation in which two transmitting valves are used in phase opposition by which very deep modulation can be employed without distortion.

Chicago Rail-Bond. A copper rail-bond with solid terminals expanded into holes in the rails by steel drift pins.

Chimes, Electric. An old experiment in which metallic balls, hung from insulating threads, are alternately attracted by bells connected respectively to earth and to a conductor at a high potential.

Chinese Compass. In the form of a magnetic compass used by the Chinese, several centuries B.C., the south-seeking end of the needle was marked, and the stationary card was divided into 24 points. At first a needle floated on cork water, used, the pivoted needle not having been introduced until the twelfth century A.D.

Chloride of Silver Cell. A *Primary Cell* with zinc and silver electrodes and a depolariser of silver-chloride in a tube round the silver pole.

Choke. A term used, particularly in wireless telephony, etc., for an *Inductance* or *Choking Coil*.

Choke Capacitance Coupling. A method of coupling thermionic valve amplifier stages resembling *Resistance Capacitance Coupling*, except that an inductance is employed instead of a resistance in the anode circuit.

Choke Control. See **CHOKER MODULATOR.**

Choke Coupling. See **CHOKER CAPACITANCE COUPLING.**

Choke Modulator. A *Modulator* in a wireless transmitting station, in which the oscillations from the plate circuit of a control valve are applied to a choking coil in series with the plate circuit of the main oscillating valve, thus varying the amplitude of its oscillations. Also called *Heising Modulator*.

Choking Coil. A coil of few or many turns, with or without a fixed or movable iron core, used to introduce *Inductance* into a circuit for limitation or regulation of the current, for balancing the effect of *Capacitance* or for other

purposes. (Also called *Inductor*, *Choke*, *Choke Coil*, *Impedance Coil*, *Kicking Coil*, and *Reactance Coil*.)

Chopper. See **TICKER**.

Chord-Winding. An armature winding connected in a manner which avoids *Demagnetising Turns*.

Chromium Plating. Electro-deposition of a layer of chromium on metal objects to form a hard bright non-oxidisable surface. The articles are usually plated with some other metal such as nickel first.

Chronograph (Electric). Apparatus for measuring and recording, with a high degree of accuracy, intervals of time; usually by closing contacts so as to send current impulses which energise electro-magnets causing a recording pen to make indications on a paper strip travelling at a known speed.

Chronopher. A contact maker for sending impulses over a line from an observatory or other standard clock to give standard time signals.

Chuck, Magnetic. See **MAGNETIC CHUCK**.

Ceiling Voltage. An expression sometimes used for the highest voltage that a machine can be made to give under working conditions.

Circle, Dip. See **DIP-CIRCLES**.

Circle Coefficient. A name for the *Leakage Factor* of an induction motor.

Circle Diagram. A circular diagram, showing the properties of induction and other alternating current motors in a convenient form.

Circuit (Electric). A closed conducting path through which a current can flow; or one of a number of parts of a circuit which are connected in parallel. See also **MAGNETIC CIRCUIT**, **OPEN-CIRCUIT**, etc.

Circuit: **Acceptor**, **Aerial**, **Anode**, **Antidyne**, **Aperiodic**, **Armstrong**, **Boucherot**, **Bourne**, **Branch**, **By-product**, **Closed**, **Cockaday**, **Communication**, **Control**, **Cord**, **Corrector**, **Current**, **Derived**, **Detector**, **Direct**, **Dispensable**, **Divided**, **Earth Return**, **Earthed**, **Electric**, **Exciting**, **External**, **Flewelling**, **Four-Wire**, **Grid**, **Hartley**, **Head**, **Impulse**,

Inductive, **Insulated**, **Intermediate**, **Internal**, **Inverted Line**, **Ironless**, **Junction**, **Lattice**, **Leak**, **Lecher**, **Loaded**, **Loftin-White**, **Magnetic**, **Main**, **Marx**, **Mesny**, **Metallic**, **Microphone**, **Non-inductive**, **Open**, **Open-wire**, **Order-wire**, **Orthodyne**, **Oscillating**, **Phantom**, **Physical**, **Plate**, **Plus**, **Potential**, **Power**, **Pressure**, **Primary**, **Radiative**, **Reaction**, **Receiving**, **Recurrent**, **Reflex**, **Regenerative**, **Reinartz**, **Rejector**, **Resonating**, **Return**, **Rheodyne**, **Scrambler**, **Secondary**, **Short**, **Shunt**, **Side**, **Smoothing**, **Superimposed**, **Super-phantom**, **Superposed**, **Telegraph**, **Telephone**, **Track**, **Traction**, **Transfer**, **Transmitting**, **Trip**, **Trunk**, **Tuned**, **Two-wire**, **Untuned**, **Untuned Secondary**, and **Voltage**. See **ACCEPTOR CIRCUIT**, **AERIAL CIRCUIT**, etc.

Circuit-Breaker. A switch adapted to open under short-circuit conditions arranged so that it opens the circuit automatically when certain predetermined conditions are realised, such as the rise of the current above a certain value, its reversal, etc., or can be tripped by hand so as to open instantly.

Circuit-Breaker: **Air-blast**, **Air-Break**, **Automatic**, **Auto-Pneumatic**, **Ballistic**, **Convactor**, **Cross-Jet**, **Deion**, **Delay-Action**, **Discriminating**, **Directional**, **Double-Break**, **Double-Pole**, **Expansion**, **Explosion-Pot**, **Fixed Handle**, **Free Handle**, **High Speed**, **Impulse**, **I.T.E.**, **Maximum**, **Maximum Current**, **Maximum Voltage**, **Minimum**, **Minimum Current**, **Minimum Voltage**, **Multibreak**, **Multipole**, **No Voltage**, **Oil**, **Oil-Blast**, **Oil-Break**, **Orthijector**, **Overcurrent**, **Overload**, **Overvoltage**, **Quenched Arc**, **Reverse Current**, **Single-Pole**, **Stabilised Arc**, **Thermal**, **Time-Limit**, **Triple Pole**, **Undercurrent**, **Underload**, and **Undervoltage**. See **AIR-BLAST CIRCUIT-BREAKER**, **AIR-BREAK CIRCUIT-BREAKER**, etc.

Circuitual Magnetisation. The distribution of magnetism in a piece of magnetic material such as a flat bar is said to be "circuitual" or "solenoidal" when the poles are at its ends. (Cf. **LAMBLER MAGNETISATION**.)

Circular Conductor. A conductor in a cable of circular section. Cf. **SHAPED** and **SEGMENTAL CONDUCTORS**.

Circular Magnetisation. Magnetisation of a cylinder, etc., so that the direction of the lines of force is circumferential instead of axial.

Circular Mil. A unit of area used in the United States for the cross section of wires, etc., equal to that of a circle one thousandth of an inch in diameter.

Circular Polarisation. Limitation of wave action, such as light or other electric waves at right angles to the direction of propagation, to equal action in two planes at right angles to each other. Cf. **PLANE POLARISATION**.

Circulating Currents. Currents which flow between alternating current machines or apparatus connected in parallel, owing to lack of coincidence between their e.m.f. waves, e.g. between two alternators slightly out of synchronism.

Circulation of Electrolyte (in Electrodeposition). A slow movement or flow of the electrolyte to ensure uniformity in the deposit.

Circumferential Key. A steel ring, inserted in a groove in the stator frame of a machine to retain the flanges which keep the core plates in position.

Clamping Rings. (1) The end rings which hold the segments of a commutator in place. (2) Rings placed temporarily over the segments during manufacture before the end rings are secured.

Clark Cell (or Latimer Clark Cell). A *Standard cell* for testing purposes giving an accurately known e.m.f. at given temperatures if made according to a standard specification; with zinc and mercury electrodes, an electrolyte of zinc sulphate and a depolariser or mercurous sulphate. The e.m.f. is 1.434 volts at 15°C.

Class A Insulating Materials. Fibrous materials, such as cotton, silk, paper, etc., impregnated or immersed in oil, also enamel.

Class B Amplification. Final stage amplification in a wireless receiver employing a double valve in one

bulb with a special push-pull connection resulting in economy of current. Employed particularly in battery-driven receivers.

Class B Insulating Materials. Materials capable of withstanding high temperatures, such as mica and asbestos compositions.

Class B Modulation. The application of similar principles as those of *Class B Amplification* to the final stage of a *Modulation* circuit.

Class C Insulating Materials. Porcelain, slate, quartz, pure mica, and other fireproof and refractory materials.

Class O Insulating Materials. Fibrous materials, such as cotton, silk or paper, not impregnated.

Clean Up. A term used in the incandescent lamp industry for the improvement in vacuum which occurs in a new lamp in the initial stages of running, owing to absorption of residual gases by the glass.

Clearance. Usually the minimum distance between live parts and objects at earth potential, but sometimes used for minimum distance between conductors of opposite polarity.

Clearing Key. A key on a telephone exchange switchboard for actuating a *Clearing Signal*.

Clearing Lamp. A signal lamp at a junction line position on a telephone exchange switchboard which remains alight only when one end of the junction line is disconnected and thus indicates when the other end may be cleared.

Clearing Relay. A relay in a telephone exchange which controls a *Clearing Lamp*, or other clearing signal.

Clearing Signal. A signal given automatically or otherwise that a telephone line is finished with and that the connections may be cleared by withdrawing the plugs.

Cleat Wiring. The system of wiring in which the wires are secured by cleats at intervals with no further covering than their own insulation.

Click Method (of wave measurement). A method depending upon the fact

that an audible click is produced in a receiving telephone due to sudden commencement or ceasing of oscillation in a tuned circuit coupled to that in which the frequency of the oscillations to be determined when brought into sympathy with it.

Clip, Bonding and Earthing. See BONDING CLIP and EARTHING CLIP.

Clock (Electric). Either a single clock deriving the energy to keep it going from a battery or other source of current, or one of a series of clocks controlled electrically from a single central or *Master* clock, or driven by a synchronous motor from an alternating current supply of controlled frequency.

Clock Diagram. A circular vector diagram relating to alternating currents. See also CIRCLE DIAGRAM.

Clock: Impulse Driven, Master, Primary, Secondary, Self-winding, Speaking and Synchronous. See IMPULSE DRIVEN CLOCK, MASTER CLOCK, etc.

Clock Meter. An electricity supply meter in which the current passing acts by varying the rate of a clock, e.g. the *Arm Meter*.

Cloisons. Flat sectional coils from a number of which a high tension winding such as that of an induction coil is built up.

Close. A switch, circuit-breaker, etc., is said to be closed when the contacts are together so that a current can pass (unlike a water tap which is said to be open when the current of water can pass).

Close Coupling. See TIGHT COUPLING.

Closed Circuit. A complete circuit formed entirely of conductive material. Cf. OPEN CIRCUIT.

Closed Circuit System. A system of telegraphy signalling, fire alarms, etc., in which, under normal conditions, the circuit is closed and a current passes, and the required signals are made by interrupting the current by opening the circuit.

Closed Coil Armature Winding. The usual system of continuous current armature winding, in which the winding forms an endless coil closed upon itself. Cf. OPEN COIL WINDING.

Closed Conduit. A conduit for underground tramway conductors without an open slot, e.g. a *Surface Contact System*.

Closed Core Transformer. A transformer with a magnetic circuit entirely of iron.

Closed Magnetic Circuit. A *Magnetic Circuit* formed entirely of magnetic material, e.g. a ring of iron, in which the flux does not pass through the air and consequently no poles are formed.

Closed Slots. Slots in armature, rotor, or stator cores entirely closed in and forming tunnels in the iron close to the surface, into which the winding can only be introduced from the ends. Sometimes used in alternating current machinery to obtain even flux distribution and mechanical strength, but having the disadvantage of increasing the reactance.

Cloud Chamber. See WILSON CLOUD CHAMBER.

Clutch Arc Lamp. A form of arc lamp in which the carbons are fed forward by releasing a clutch electromagnetically as the current in the arc drops below its normal value by the increase of the arc length owing to the carbons burning away.

Clutch, Magnetic. See MAGNETIC CLUTCH.

C.M.B. Converter. See AUTO-CONVERTER.

CO₂ Indicator or Recorder (Electric). An electrically worked instrument for indicating or recording the percentage of CO₂ in flue gases. One of these depends on the differences in resistance of two identical platinum wires heated electrically and cooled by currents of air and the flue gas under test respectively. Most CO₂ recorders are purely chemical in their action.

Coal Cutter (Electric). A self-contained coal cutting machine worked by an electric motor or motors which drive, through suitable gearing, a cutter of the bar, disc, chain, percussive, or other type.

Coating (of a Condenser). The metallic plates, sheets or films,

forming the conductors of a condenser, whether attached to the dielectric as in the original *Leyden Jar* or not.

Coaxial Cable. A form of cable used for high frequency communication circuits, including television, in which the cores consist of a copper tube surrounding a central core, either supported by discs, with the intervening space filled by air or nitrogen or by a special insulating material.

Coaxial Carbons. Carbons arranged in an arc lamp, in line with each other either vertically or slightly inclined or horizontal as in some projector lamps.

Cockaday Circuit. A highly selective circuit for wireless reception in which the aerial is coupled to the secondary circuit of a transformer with a single turn primary; the secondary circuit being loosely coupled to the grid circuit of the first valve.

Codd Cell. A single-fluid zinc-carbon primary cell with a picric chloride depolariser in which the carbon electrode lies horizontally at the bottom covered by a layer of inert powder.

Code Ringing. *Party Line Ringing* in which all the subscribers' bells are connected across the line and ring at once. Different code signals are given to indicate which station is being called.

Code Selector. A selector in an automatic telephone exchange where a call is started which works on an alphabetical code and makes required connections to outgoing junctions to other exchanges or to group selectors in its own exchange.

Code Wire. Insulated wire supposed to conform with certain requirements drawn up by the United States Board of Fire Underwriters. See **NATIONAL ELECTRIC CODE**.

Coder. The apparatus used in conjunction with a *Call Indicator* which receives and stores the calling impulses and discharges them in a suitable form when a call indicator position is available.

Coefficient: Breadth, Circle, Contra-

tion, Coupling, Dielectric, Dispersion, Flux, Fringing, Gap, Extension, Grading, Heating, Hysteresis, Kapp, Loss, Output, Peltier, Radiation, Specific Utilisation, Spreading, Steinmetz, Voltage, Weight, and Winding. See **BREADTH COEFFICIENT**, **CIRCLE COEFFICIENT**, etc.

Coefficient of Absorption. See **ABSORPTION RATIO**.

Coefficient of Amplification. See **AMPLIFICATION-CONSTANT**.

Coefficient of Coupling. See **COUPLING COEFFICIENT**.

Coefficient of Diffused Reflection. See **REFLECTION FACTOR**.

Coefficient of Leakage. See **LOSS OF CHARGE**.

Coefficient of Magnetisation. *Susceptibility* per unit mass; usually referred to the molecular mass of the substance in question.

Coefficient of Mutual Induction. See **MUTUAL INDUCTANCE**.

Coefficient of Radiation. See **RADIATION COEFFICIENT**.

Coefficient of Reflection. (1) See **REFLECTION FACTOR**. (2) The term is also used to signify a factor which determines the reflection losses when telephone currents pass from one line to another of different line characteristics; numerically equal to the ratio of the difference to the sum of the respective line characteristics of the two lines. See **LINE CHARACTERISTIC**, **COEFFICIENT OF TRANSMISSION**, etc.

Coefficient of Self-Induction or Inductance. See **SELF-INDUCTANCE**.

Coefficient of Transmission. (1) See **TRANSMISSION RATIO**. (2) The factor determining the portion of a telephone current transmitted through the junction of two lines of different *Line Characteristics* after loss by reflection, numerically equal to twice the line characteristic of the second line divided by the sum of their characteristics.

Coercimeter. An instrument for measuring *Coercive Force* by determining the magnetic field from the exciting current when the component of the field perpendicular to the axis of the specimen is zero as ascertained by a search coil.

Coercive Force or Coercivity. The magnetising force which has to be

applied in a reverse direction to a magnetised body to remove the *Residual Magnetism*.

Coherer. An imperfect contact, such as that between metallic filings, two lightly touching bodies, etc., which has the property of decreasing its resistance when subjected to minute electrical impulses, and remaining in this state of improved conductivity until disturbed. Used in the earlier systems of wireless telegraphy as a detector of electric waves.

Coherer : Branly, Filings, Lodge, Lodge-Muirhead, Self-Restoring, and Solari. See BRANLY COHERER, FILINGS COHERER, etc.

Cohesion, Electrostatic and Magnetic. See ELECTROSTATIC COHESION and MAGNETIC COHESION.

Coil. Any winding of one or more convolutions spirally or helically arranged of insulated or bare wire, usually for the purpose of producing a magnetic flux or considerable inductance or disposing wire required to form a certain resistance in a compact space.

Coil(s) : Armature, Auxiliary, Basket, Blow-out, Choking, Compensating, Compounding, Damping, Dead, Diamond Type, Drainage, Duolateral, Earth, Earthing, Eikmeyer, Exciting, Exploring, Field, Former-Wound, Heat, Heating, Honeycomb, Impedance, Inductance, Induction, Kicking, Lap, Lattice, Leak, Loading, Magnet, Magnetising, Medical, Multiple, Mush-Wound, Pancake, Phasing, Plug-in, Pressure, Preventive, Primary, Pulled, Pupin, Reactance, Reaction, Repeating, Resistance, Retardation, Ribbon, Ruhmkorff, Search, Secondary, Sectional, Series, Shocking, Short-Throw, Short-Type, Shunt, Single-Turn, Skew, Slab, Sledge, Spark, Sparking, Spiral, Strap, Tesla, Thomson-Varley, Tickler, Trembler, Tuning and Vernier. See ARMATURE COIL, AUXILIARY COIL, etc.

Coil Ignition. Ignition in internal combustion engines by a spark produced by an *Induction Coil*, usually supplied by an accumulator. Cf. MAGNETO IGNITION, and see also DISTRIBUTOR (4).

Coil-Driven Loud Speaker. See MOVING COIL LOUD SPEAKER.

Coil-Loading. The addition of inductance to a telephone line or cable by separate inductance coils (*Pupin Coils*) at intervals, as opposed to *Continuous Loading*.

Coil-Side. That part of an armature coil consisting of one or more conductors lying in a single slot.

Coiled-Coil Filament. A type of tungsten lamp filament in which the drawn wire is coiled on itself and the coil thus formed is further wound into a coil before being mounted on a spider in the usual way. This compact arrangement presents less surface for loss of heat by conduction to the gas and increases the efficiency.

Cortion, Magnetic Sphere of. See MAGNETIC CORTION, SPHERE or CORTION.

Cold Cathode. A cathode in an "X" ray or other cathode ray tube which is not heated to facilitate the disengagement of electrons; requiring a very much higher voltage than a *Hot Cathode*.

Cold Emitter Valve. A *Thermionic Valve* in which the cathode does not require heating to render it emissive.

Cold Galvanising. See ELECTRO-GALVANISING.

Cold Valve. A term sometimes used for a rectifier of the copper oxide type when used as a detector in wireless reception.

Collecting Electrode (in Electrical Precipitation). See PASSIVE ELECTRODE.

Collecting Rings. See SLIP RINGS.

Collecting Shoe. See CONTACT SHOE.

Collector. (1) Any sliding contact apparatus which moves relatively to another and maintains contact with it for the conveyance of current; such as a set of slip rings or the apparatus on an electric railway or tramway car, locomotive, etc., which collects the current from the overhead contact line or conductor rail. (2) The part of an electrostatic machine, by which the charge is collected.

Collector : Bow, Comb, Pantagraph and Rod. See BOW COLLECTOR, COMB COLLECTOR, etc.

Collector Rings. See SLIP RINGS.

Collector Shoe. See CONTACT SHOE.

Collector Strip. The renewable curved bar (usually) of aluminium which makes contact with the line in a *Bow* or *Pantograph Collector*.

Colloid Rectifier. A rectifier with an anode of colloidal particles in suspension in a non-electrolysable liquid and a cathode of a metallic oxide.

Colloidal Filament. A metal filament for incandescent lamps prepared by a process involving the use of colloidal substances.

Column, Positive. See POSITIVE COLUMN.

Comb. A conductor with a row of parallel projecting points facilitating the passage of a high tension discharge: used in a form of lightning arrester and as a collector in electrostatic machines.

Comb Collector. See COMB.

Comb Lightning Arrester. A lightning arrester for telegraph and telephone circuits, where an air-gap between two metal combs is provided across which a high tension discharge can pass.

Comb Poles. Dynamo poles in which alternate laminations of the shoes are made shorter than the others to improve the distribution of flux.

Combination Duplex. The usual method of connecting up apparatus for single current duplex working, in which, when both keys are depressed, the two batteries add their effects in the line. Cf. OPPOSITION METHOD.

Combined Distribution Frame. A frame in a small telephone exchange which combines the purposes of a *Main* and an *Intermediate Distribution Frame*.

Combiner. The part of the mechanism in a printing telegraph instrument in which the combinations forming the distinctive letter signals are brought together and caused to select the letter to be printed.

Commercial Efficiency. Overall efficiency, after allowance has been made for all mechanical as well as electrical losses.

Common Battery System. See CENTRAL BATTERY SYSTEM.

Common Control Automatic Tele-

phone System. A telephone system having similar objects as the *Bypath System* effected in a different way.

Common Frequency Working (of Broadcasting Stations). The working of several *Relay Stations* simultaneously at the same frequency when giving the same programme.

Common Return. A conductor forming a *Return Circuit* to several otherwise separate circuits.

Communal Aerial. An aerial on a building such as a large block of flats with specially shielded connections suitable for high frequency currents to each tenant in the building.

Communication (Electrical). The whole subject of the science and practice of telegraphy and telephony including wireless, and of all other methods of electrical signalling. See also LIGHT CURRENT ENGINEERING.

Communication Channel. A wider term than *Communication Circuit*, including provision for wireless or carrier current telegraphy and telephony, etc., and all forms of *Phantom* and *Superposed* circuits.

Communication Circuit. Any telegraph, telephone, or other signalling circuit.

Communicator. The sending apparatus in the Wheatstone A.B.C. telegraph system, which causes the number of current impulses corresponding to the required letter to be transmitted.

Commute. To convert an alternating current into a unidirectional current by means of a *Commutator*.

Commutating Field. The auxiliary field due to the *Commutating Poles*.

Commutating Machine. Any dynamo-electric machine provided with a *Commutator*.

Commutating Period. The time during which the part of an armature winding between two adjacent commutator segments is short circuited by the brush.

Commutating Poles. Narrow extra poles between the main poles of direct current machines, providing a local field at the point

required to assist commutation. (Also called *Interpoles*, *Auxiliary Poles*, and *Compoles*.)

Commutating Windings. Windings on *Commutating Poles*. Cf. COMPENSATING WINDING.

Commutating Zone. The angle swept out by the centre line of a slot in an armature during the time that the coils therein are short-circuited by the brushes.

Commutation. The collection of current by brushes from a commutator; involving reversal of the current in the armature coils and short-circuiting of parts of the winding as the brush segments connected thereto come under the brush. Unless this short circuit is broken when there has ceased to be any e.m.f. between the adjacent segments, *Sparking* will be produced. See SPARKLESS COMMUTATION, etc.

Commutation : Axis of, Forced, Selective and Sparkless. See AXIS OF COMMUTATION, FORCED COMMUTATION, etc.

Commutation Poles, Windings, etc. See COMMUTATING POLES, etc.

Commutator. Originally, any device for reversing the direction of a current, and still used for some forms of reversing keys, etc., but usually meaning the drum built up of insulated segments connected to the armature winding of a d.c. generator or motor from which the current is collected by the brushes. See COMMUTATION.

Commutator : Capacitance, Disc, Radial, Rectifying, Reversing, Shrink-Ring, Three-Part, Thyatron, Two-Part, V-Type, Ventilated, Wearing Depth of. See CAPACITANCE COMMUTATOR, DISC COMMUTATOR, etc.

Commutator Bar. See COMMUTATOR SEGMENT.

Commutator Brush. See BRUSH.

Commutator Bush. See COMMUTATOR SLEEVE.

Commutator Grinder. A self-contained electrically driven grinding apparatus provided with the necessary feed motions, etc., which can be mounted on a direct current machine, so that the surface of the commutator can be

ground true without removal of the armature.

Commutator Hut. See COMMUTATOR SLEEVE.

Commutator Loss. The energy loss in a machine due to causes connected with the commutator; including (1) Resistance of the segments, (2) Resistance of the brushes, (3) Contact resistance between the brushes and the segments allowing for unequal distribution of the current, (4) Sparking, (5) Brush friction and (6) Eddy currents in the segments.

Commutator Lug. The copper strip usually riveted and soldered to the end of the commutator segment, with which connection is made to the armature coils. Sometimes the lugs are made solid with the segments. (Also called *Commutator Riser*.)

Commutator Motor. A motor of the class that is provided with a commutator. Used particularly of A.C. Motors of this class to distinguish them from induction motors, etc.

Commutator Motor : Polyphase, Single-Phase, and Three-Phase. See POLYPHASE COMMUTATOR MOTOR, SINGLE-PHASE COMMUTATOR MOTOR, etc.

Commutator Rectifier. An apparatus for rectifying alternating currents by the periodical reversal of connections by a commutator driven by a synchronous motor.

Commutator Ring. Usually, the *End Rings* of cast-iron, made to fit the dovetail of the commutator segment, which are held by bolts or screws so as to clamp the segments firmly in place; but also used to signify the V-shaped rings of mica, or other insulating material, which insulate the segments from the end rings. See CLAMPING RINGS, END RINGS, V-RINGS, etc.

Commutator Ripples. Small periodic variations in the voltage of a machine, caused by and synchronous with the passage of the individual commutator segments under the brushes.

Commutator Riser. See COMMUTATOR LUG.

Commutator Segment. One of the copper strips of which, alternately with insulating plates, the commutator is made up; also called *Commutator Bars*. (The term is also occasionally used for the mica strips which separate the copper segments.)

Commutator Shell. See *COMMUTATOR SLEEVE*.

Commutator Shrink-Ring. A steel ring shrunk on to a commutator, over a layer of mica or other insulating material, to hold the segments against centrifugal force in the case of very high speeds as in D.C. Turbo-Generators.

Commutator Sleeve. A sleeve, carried by the armature shaft, upon which the commutator is built up, also called *Commutator Shell*, and in the smaller sizes *Commutator Tube* or *Bush*.

Commutator Spider. A structure with spokes, which, in the case of large machines, is carried on the shaft, independently of the Armature itself, and upon which the *Commutator* is built up.

Commutator Tag. See *COMMUTATOR LUG*.

Commutator Transformer. A converting apparatus for producing high tension continuous currents from a small battery. The battery current passes through a reversing commutator driven by a motor to a step-up transformer, and the high tension alternating current produced is rectified by a second commutator driven synchronously with the first. Sparking is prevented and the wave form is smoothed out by combinations of capacity and inductance.

Commutator Tube. See *COMMUTATOR SLEEVE*.

Compandor. A system of improving speech to noise ratio in wireless reception by compressing the range of the emitted signal energy variation by a "compressor" and expanding it again at the receiving apparatus by an "expander."

Comparison Lamp (in Photometry). A lamp, not itself a standard, used for successive comparison with a source under test and a standard.

Compass (Magnetic). An instrument

in which a magnetised system mounted so as to be free to rotate in a horizontal plane, is employed to indicate the direction of North, South, and other bearings. The magnetic compass was known to the Chinese some centuries B.C., but does not appear to have been introduced into Europe until about the fourteenth century A.D.

Compass: Azimuth, Chinese, Earth Inductor, Gyrostatic, Kelvin, Magnetic, Magnetometer, Mariner's, Prismatic, Thomson, and Wireless. See *AZIMUTH COMPASS*, *CHINESE COMPASS*, etc.

Compass Card. The pivoted and sometimes floating disc, carrying the magnetic needle or needles and marked with the points of the compass in the usual form of *Mariner's Compass*.

Compass Errors. The various causes due to local conditions on board a ship which would prevent the compass from indicating accurately unless corrective precautions were taken. (See *CARGO ERROR*, *HEELING ERROR*, *SEMICIRCULAR ERROR*, *QUADRANTAL ERROR*, and *FLINDERS BAR*.)

Compass Needle. The pivoted, magnetic needle, which, in the older form of compass, moves over a dial marked with the points of the compass, or, in the more usual type, the magnet or magnets attached to the moving card on which the points are marked.

Compensated Alternator. An alternator with the equivalent of a compound winding to compensate for voltage drop on load.

Compensated Induction Motor. An induction motor with the addition of a second rotor winding with a commutator fed from a transformer for power factor compensation.

Compensated Repulsion Motor. A form of single-phase commutator motor combining the principles of the series and repulsion types; with a set of brushes in series with the field winding as well as a short circuited set. Suitable for electric traction purposes. (Also known as the *Latour-Winter-Eichberg Motor*.)

Compensated Series Motor. A series wound single-phase commutator motor with a compensating winding to neutralise the armature ampere-turns.

Compensated Shunt Box. A *Shunt Box* arranged so that at each step a different compensating resistance is inserted in series with the galvanometer so that the total resistance of galvanometer and shunt is not altered.

Compensated Voltmeter. A voltmeter which is arranged to read the voltage at the end of a feeder by means of an additional winding carrying a current proportional to the feeder current in opposition to the ordinary voltage winding.

Compensated Wattmeter. A wattmeter in which an additional opposing voltage winding is provided to compensate for the effect of the voltage circuit current in the current coil.

Compensating Coil. A part of a compensating winding in dynamo-electric machinery, or in meters an additional coil to provide a torque compensating for friction, either at starting and at low loads, or, in the case of mercury meters, at high loads.

Compensating Field. The field produced by a compensating winding; sometimes also used for the field produced by a *Commutating Pole*.

Compensating Poles. One of the names sometimes adopted for *Commutating Poles*, *Interpoles*, or *Auxiliary Poles*.

Compensating Winding. (1) In a continuous current generator, a distributed winding in the pole face to neutralise the cross ampere-turns of the armature for the improvement of commutation. (2) In single-phase commutator motors, etc., a winding to neutralise the inductance component of the armature flux to improve the power-factor.

Compensation. The provision of some auxiliary effect which neutralises automatically some disturbing effect. See COMPENSATING WINDING, COMPENSATING COIL, COMPENSATED VOLTMETER, etc.

Compensation, Conductive, Inductive

and **Residual.** See CONDUCTIVE COMPENSATION, INDUCTIVE COMPENSATION, etc.

Compensation of Power-Factor. See POWER-FACTOR COMPENSATION.

Compensator. In general, a piece of apparatus which corrects some disturbing action, e.g. in wireless reception, a variable condenser placed between the grid of one valve and the plate of a succeeding valve to check self-oscillation. Also sometimes used as the equivalent of *Auto-Transformer*, particularly in connection with its applications to balancing and motor starting.

Compensator, Attenuation and Neutral. See ATTENUATION COMPENSATOR and NEUTRAL COMPENSATOR.

Compensator Balancer. See ALTERNATING CURRENT BALANCER.

Compensator Starter. Apparatus for starting induction motors by applying to the stator a reduced voltage obtained from a *Compensator* or *Auto-Transformer*.

Compensator Transformer. See COMPENSATOR.

Complete Cycle. See CYCLE.

Compole. Abbreviation for *Commutating Pole*.

Component: Active, Electromagnetic, Electrostatic, Energy, Horizontal, Idle, In-phase, Magnetising, Oscillating, Power, Quadrature, Reactive and Vertical. See ACTIVE COMPONENT, ELECTROMAGNETIC COMPONENT, etc.

Composite Balance. (Kelvin). An instrument similar to the Kelvin ampere balances but provided with moving coils of fine wire so that it can be used as a watt-meter.

Composite Cable. Cable for telephone purposes containing wires of more than one size laid up together.

Composite Conductor. A conductor composed of more than one material, e.g. an *Aluminium-Steel* cable.

Composite Machine. A term sometimes used for machines, or sets of machines, for conversion or transformation of electric currents, e.g. *Rotary Converters*, *Motor-Generators*, *Frequency Changers*, etc.

Composited Circuit. A two-wire telephone circuit arranged so that its two wires can be used to form

two superimposed duplex telegraph or other signalling circuits; sometimes employed for call and other signals on *Junction Lines*.

Compound Alternator. See COMPENSATED ALTERNATOR.

Compound Brushes. Brushes consisting of alternate layers of copper and carbon; having better longitudinal conductivity than carbon brushes while still or sufficient lateral resistance to facilitate good commutation.

Compound Catenary Suspension. A form of *Catenary Suspension* employing an intermediate bearer wire from which the contact line is suspended at frequent intervals.

Compound Dynamo or Generator. A dynamo having a series field winding to compensate for the drop of voltage on load, as well as a shunt winding; also called COMPOUND WOUND DYNAMO OR GENERATOR.

Compound Excitation. The provision of both shunt and series excitation to a machine. See COMPOUND DYNAMO AND COMPOUND MOTOR.

Compound-Filled Switchgear, etc. Metal-clad apparatus with all possible spaces between live parts and the casing filled in with compound.

Compound, Insulating. See INSULATING COMPOUND.

Compound Magnet. A permanent magnet made up of several laminations.

Compound Motor. A motor having in addition to a shunt field winding, a series winding which reinforces the field and gives a good starting torque without sacrificing the speed limiting properties of the shunt winding. Cf. DIFFERENTIALLY WOUND MOTOR.

Compound Winding. A field winding composed of both shunt and series coils.

Compound Winding, Cumulative and Differential. See CUMULATIVE COMPOUND WINDING AND DIFFERENTIAL COMPOUND WINDING.

Compound Wound Dynamo, Generator and Motor. See COMPOUND DYNAMO AND MOTOR.

Compound Wound Relay, etc. A relay or other similar instrument

provided with windings connected to one or more separate circuits.

Compounding Coil. A series coil added to convert a shunt into a *Compound Winding*.

Compounding: Differential, Flat, Level, and Over. See DIFFERENTIAL COMPOUNDING, FLAT COMPOUNDING, etc.

Compressed Air Capacitor. See COMPRESSED AIR DIELECTRIC.

Compressed Air Dielectric. On account of the increased dielectric properties of gases at higher pressures, compressed air is sometimes used as an insulator, or as the dielectric in a capacitor.

Compressed Air Lamp. A self-contained lamp for use in fiery mines, comprising a small air turbine driving a generator connected to an incandescent lamp, driven from the compressed air power system where electric mains are not permitted or available.

Compressor. (1) See AIR COMPRESSOR. (2) See COMPANDOR.

Compton Effect. The change of wavelength of "X" Rays when scattered by incidence on certain surfaces.

Concatenated Motor. See CASCADE MOTOR.

Concatenation. See CASCADE.

Concave Cathode. A cathode in an "X"-Ray or other *Cathode Ray Tube*, presenting a concave surface towards the anode or anti-cathode.

Concentrated Winding. A winding concentrated in single slots or round a core as opposed to a distributed winding spread over a number of slots. See also SEMI-DISTRIBUTED WINDING.

Concentration Cell. A double fluid primary cell with electrodes of the same metal in electrolytes consisting of a salt of that metal of different degrees by concentration. During the action the strengths of the two are gradually equalised by solution of one electrode and deposit on the other.

Concentration of Potential. The way in which the end turns of the windings of high tension apparatus such as transformers are subjected to a very large proportion of the voltage when suddenly switched

on to a circuit, and therefore require much heavier insulation than the rest of the winding.

Concentrator. A switchboard equipped with plugs and jacks by which the circuits in a large telegraph office can be re-arranged on Sundays, at night, etc., so that they can be attended to by a small number of operators.

Concentric Cable. Cable in which one conductor entirely surrounds another, although insulated from it. See **TWIN CONCENTRIC**, and **TRIPLE CONCENTRIC**.

Concentric Coils. Armature coils in which the connections between individual conductors do not cross. Cf. **LATTICE COILS**.

Concentric Connections. End connections of *Concentric Coils*.

Concentric Plug and Socket. A plug and socket connection in which one contact consists of a central pin and the other of a ring surrounding it.

Concentric Winding. A winding composed of *Concentric Coils*.

Concentric Wiring. Interior wiring by twin conductors consisting of a central insulated core surrounded by flexible metal tube, usually uninsulated and earthed.

Condensance. Another name for *Capacitance Reactance*; the component of the impedance due to the effect of capacitance in the circuit, corresponding to *Inductive Reactance* which is the component due to electromagnetic causes. See **REACTANCE**.

Condenser (or Capacitor). A system consisting of two conductors of considerable surface separated by a comparatively thin dielectric, and thus possessing an appreciable *Capacitance*. A common type consists of a pack of alternate sheets of tinfoil and mica or paper impregnated with paraffin wax or petroleum jelly, the odd sheets of tinfoil connected to one terminal and the even sheets to the other. Used for a variety of purposes in electrical apparatus on account of their properties of absorbing considerable charges when "charged" and delivering them up when "discharged," of allowing

alternating but not direct currents to pass, advancing the phase of an alternating current and balancing the effect of inductances. On account of other meaning of the word, the term *Capacitor* is now preferred for any system of appreciable capacitance. The term condenser has also been used for other classes of apparatus having a phase advancing effect. See **ROTARY** and **SYNCHRONOUS CONDENSERS**.

Condenser: Adjustable, Air, Anti-Interference, Asynchronous, Auto-, Billi, Block, Blocking, Bridging, By-pass, Compressed Air, Dry Electrolytic, Dynamic, Electrochemical, Electrolytic, Gang, Grid, Mansbridge, Moscicki, Neutralising, Plain, Plate, Pole-type, Reaction, Reading, Rotary, Series, Shortening, Shunted, Signalling, Smoothing, Square Law, Standard, Static, Straight Line, Capacitance, Straight Line Frequency, Straight Line Wave Length, Super-excited Synchronous, Telephone, Time Constant of, Tuning, Variable, and Vernier. See **ADJUSTABLE CONDENSER**, **AIR CONDENSER**, etc.

Condenser Coupler. An arrangement to take the place of a *Voltage Transformer* for coupling a voltmeter to high-tension conductors, consisting of two capacitors (condensers) in series, the voltmeter connection being taken from the point between them. Cf. **CAPACITOR TRANSFORMER**.

Condenser Microphone. See **CONDENSER TRANSMITTER**.

Condenser Potential Divided. See **CONDENSER COUPLER**.

Condenser Receiver. An electrostatic telephone receiver consisting essentially of a condenser with one electrode free to vibrate under the influence of the variable attraction of the other.

Condenser Transmitter. An apparatus similar to a *Condenser Receiver* in which the variations in capacitance produced by the vibrations of the diaphragm produce modulations of the line current.

Condenser Type Bushing. A form of insulating bush for high-tension transformer terminals, in which alternate concentric layers of

metal and insulation are used to improve the voltage distribution.

Condenser Type Terminal. See CONDENSER TYPE BUSHING.

Condensing Electroscopes. A gold leaf electroscope combined with a small plate condenser which can have its upper plate removed in order to magnify the effect of a charge by largely decreasing the capacity of the electroscope.

Condensive Load. See LEADING LOAD.

Condensive Resistance. See CAPACITANCE REACTANCE.

Conductance. The reciprocal of Resistance or, in the case of alternating current, the energy component in the reciprocal of Impedance. Measured in *Mhos*. Symbol: *G* or *g*.

Conductance: Anode, Anode A.C., Grid, Mutual A.C., and Specific. See ANODE CONDUCTANCE, ANODE A.C. CONDUCTANCE, etc.

Conduction. The transmission of electricity through a body in the form of a current, by a drift of negative electrons in one direction. See also ELECTROLYTIC CONDUCTION.

Conduction Current. The transmission of electricity by a true Current through a body as opposed to by Convection.

Conductive Compensation. Compensation of a single-phase motor, or similar apparatus, by a winding which receives its current by Conduction. Cf. INDUCTIVE COMPENSATION.

Conductive Coupling. The connection of two circuits or parts of a circuit so that current flows between them by conduction. Cf. INDUCTIVE COUPLING.

Conductive Discharge. A discharge of electricity, as from a condenser, by a current through a conductor. Cf. CONVECTIVE DISCHARGE and DISRUPTIVE DISCHARGE.

Conductivity. The power of a material to conduct electric currents; measured either as the reciprocal of Volume Resistivity or as the percentage which the conductivity of one substance is of that of a standard substance (such as pure copper). Symbol: *G* or *g*. Cf. CONDUCTANCE, etc.

Conductivity: Alternating Current, Anisotropic, Isotropic, Photoelectric, Specific, Super- and Unilateral. See ALTERNATING CURRENT CONDUCTIVITY, ANISOTROPIC CONDUCTIVITY, etc.

Conductivity Bridge. A form of Wheatstone's Bridge used for the comparison of low resistances; usually with the comparison resistances arranged in parallel instead of in series.

Conductivity Test. See FALL OF POTENTIAL TEST.

Conductor. Any material possessing an appreciable proportion of free electrons, which therefore permits a current to pass. Any particular object, such as a wire or group of strands in a cable, made of such a material.

Conductor(s): Aerial, Armature, Bare, Bunched, Cellular, Circular, Composite, Earthed, Electrolytic, External, Hidden, Inner, Internal, Laminated, Lightning, Live, Locked Coil, Neutral, Outer, Overhead, Plain, Prime, Ribbon, Screened, Second Class, Segmental, Shaped, Solid, Stranded, Super-, Third Class, Tinned, Transposed, Transposition of, Twin, Twisted, and Uninsulated. See AERIAL CONDUCTOR, ARMATURE CONDUCTOR, etc.

Conductor Rail. An insulated rail between or alongside the running rails in electric railways for conducting the current to the collectors on the train. See THIRD RAIL, FOURTH RAIL, LIVE RAIL, TOP CONTACT RAIL, SIDE CONTACT RAIL, UNDER CONTACT RAIL.

Conductor Rail, Depressed and Spliced. See DEPRESSED CONDUCTOR RAIL and SPLICED CONDUCTOR RAIL.

Conductor Rail Anchor. A device for fixing a conductor rail at some point as regards longitudinal movement.

Conductor Rail Bond. A conducting Bond between lengths of conductor rail.

Conductor Rail Insulator. An insulating support for a conductor rail usually consisting of a porcelain body with or without a metal stand and cap.

Conductor Rail System (of Electric Traction). The system of conveying current to the trains by insulated conductor rails parallel to the track through shoes carried on the vehicles.

Conduit. A covered or uncovered trough, or a pipe or tube, in which wires, cables, or other conductors are run.

Conduit : Bituminous, Closed, Earthenware, Interior, Plain, Screwed, Slip, Slotted, Steel, Stoneware, and Underground. See BITUMINOUS CONDUIT, CLOSED CONDUIT, etc.

Conduit Box. A box with one or more outlets to take conduit tubes for mounting switches and accessories or making joints, etc.

Conduit Fittings. Accessories such as conduit boxes, bends, tees, couplers, etc., for joining length of conduit tube for wiring.

Conduit System. (1) Of electric traction : A system of conveying current to trolleys, etc., by conductors running in a conduit provided with an open slot level with the road through which a *Plough* attached to the car makes contact with the conductors, (2) Of Wiring : The system of wiring of buildings in which the conductors are enclosed in tubes throughout.

Cone Loud Speaker. A *Loud Speaker* of the *Hornless* type in which a large conical surface of thin flexible material is thrown into vibration by an electromagnetically actuated diaphragm or reed.

Confined Discharge Arrester. An arrester in which the rectifying power of an arc confined in a narrow passage is made use of to prevent the power current following to arc of the discharge.

Connected Load. The sum of the rated consumption of all the lamps, motors, and other apparatus connected to a system, i.e. the load if all were in use at once.

Connection(s) : Bridge, Butterfly, Cascade, Concentric, Cross, Desauter, Delta, Double Delta, Double Zig-Zag, Earth, End, Equalising, Equipotential, Evolute, Fork, Interconnected Star, Involute, Isle of Man, Lattice, Mesh, Multiple-Series, Parallel, Parallel-Series,

Scott, Series, Series-Multiple, Series Parallel, Spiral, Star, Steinmetz, Tandem, Taylor, "V," "Y," and Zig-Zag. See BRIDGE CONNECTION, BUTTERFLY CONNECTIONS, etc.

Connection Box. A box containing conveniently arranged terminals to which connections can be made to branch circuits, etc.

Connector. (1) Any device by which two conductors may be joined together so that current can pass from one to the other. (2) A name sometimes given to the *Line Selector* in an *Automatic Telephone Exchange* which connects the calling line to the called line.

Connector, Mechanical. See MECHANICAL CONNECTOR.

Consequent Pole Generator or Motor. A machine in which alternate poles do not carry windings, being of the nature of *Consequent Poles*.

Consequent Poles. Points on a magnetic circuit where two poles of like polarity occur together due to the contiguity of portions of the circuit where the lines of force are in opposite directions producing the effect of a single intermediate pole.

Constant : Amplification, Attenuation, Baur's, Curie, Galvanometer, Hysteric, Kerr's, Migration, Oscillation, Propagation, Radiation, Radioactive, Regulation, Resonance, Time, Verdet's, and Wave-Length. See AMPLIFICATION CONSTANT, ATTENUATION CONSTANT, etc.

Constant Current. A current the effective value of which does not vary in value while it is flowing.

Constant Current Dynamo or Generator. A *Generator* which is so controlled, either automatically or otherwise, as to give a constant current at all loads, while the voltage is varied as required.

Constant Current Motor. A *Motor* arranged to run upon a *Constant Current System*.

Constant Current System. A system of distribution in which the current but not the voltage is kept constant, and all the generators, motors, etc., are connected in series. See THURY SYSTEM.

Constant Current Transformer. A

Transformer designed to give a constant current in its secondary at a varying voltage.

Constant Current Welding. A system of arc-welding in which the source of current is arranged to keep the current constant automatically within a certain range of voltage variation.

Constant Frequency Drive. The complete equipment for ensuring constancy of frequency in a wireless transmitter, including *Master Oscillator, Amplifier, and Separator Buffer*.

Constant Potential Dynamo or Generator. See **CONSTANT VOLTAGE DYNAMO OR GENERATOR**.

Constant Potential System. A system of distribution in which the voltage remains constant at all currents, being the usual system of distribution with all the consuming appliances (lamps, motors, etc.) in parallel across the mains.

Constant Power Generator. A *Generator* regulated automatically or otherwise to give a constant output in watts at varying currents by corresponding variation of voltage.

Constant Power Welding. A system of arc-welding in which the source or current is arranged to keep its power output constant with varying current and voltage.

Constant Speed Motor. A motor regulated automatically or otherwise to run at a constant speed at all loads. See **DIFFERENTIALLY WOUND MOTOR** and **SYNCHRONOUS MOTOR**.

Constant Time Lag, Time Element, etc. See **DEFINITE TIME LAG**.

Constant Voltage. An effective voltage regulated to vary only within very fine limits.

Constant Voltage Dynamo or Generator. A *Generator* arranged to give a constant voltage at all loads. See **CONSTANT POTENTIAL SYSTEM**.

Constant Voltage Motor. A *Motor* arranged to run on a *Constant Potential System*.

Constant Voltage Welding. A system of *Arc-welding* in which the source of current is arranged to maintain a constant voltage within certain limits of current variation.

Constantan. A copper-nickel alloy of high specific resistance and almost negligible temperature coefficient at ordinary temperatures; containing about 45 per cent of nickel.

Consumer's Terminals. The terminals of a consumer's installation where it is connected up to the supply authorities' service.

Consumption, Specific. See **SPECIFIC CONSUMPTION**.

Contact. (1) Two conductors are said to be in "contact" when they are contiguous to an extent which is sufficient for a current to flow between them. (2) The part of either of two conductors made to touch when required in switches, etc. (3) In automatic telephony, the individual fixed contact pieces each connected to a different line arranged in rows or *Levels* to form the *Bank* of contacts over which the *Wiper* moves in a *Selector*.

Contact(s): Arcing, Auxiliary, Blast, Boxed, Brush, Carbon, Finger-Type, Floor, Gate, Inverted Brush, Laminated, Make and Break, Platinum, Relay, Reverse Brush, Rubbing, Secondary, Self-Cleaning, Sliding, Sparking, Surface, "V" Type, Wedge, and Wipe. See **ARCING CONTACT**, **AUXILIARY CONTACT**, etc.

Contact-Breaker. A device for repeatedly breaking and re-establishing a circuit, either magnetically, as in the trembler of a bell or an induction coil, or otherwise.

Contact Drop. A potential drop due to contact resistance, such as that between brushes and a commutator.

Contact Electricity and Contact E.M.F. See **CONTACT POTENTIAL**.

Contact Fingers. Fixed contact pieces, pressed by springs against the moving contacts in a controller, etc.

Contact Jaws. (1) The fixed contacts in knife and other types of switch with which the blade makes contact. (2) In electric welding. The clamps which secure the piece to be welded and convey the current thereto.

Contact Line. The overhead bare wire from which the current is taken by the trolley or collector in electric tramways and railways.

Contact-Maker. Any conducting brush or piece used to make contact at times with another conductor, but more particularly an apparatus for closing a circuit automatically at a particular time, as for the purpose of controlling ignition in internal combustion engines; or for experimental determinations of instantaneous values of e.m.f.'s, currents, etc.

Contact Method. Any method of measuring speeds, slip, etc., employing a revolving contact-maker.

Contact Potential. The difference of potential which is produced when two dissimilar metals are placed in contact.

Contact Rail. See CONDUCTOR RAIL.

Contact Resistance. The resistance of the junction of two contiguous conductors due to their imperfect contact, or to a minute film of some other material between them.

Contact Segment. A contact in a face-plate type starter or multiple contact regulating switch, etc., forming a segment into which a flat ring is divided by radial gaps.

Contact Series. See ELECTROCHEMICAL SERIES.

Contact Shoe. The collector on an electric train, car, crane, etc., which picks up the current from the *Conductor Rail*.

Contact Skate. A long conductor with rounded ends suitably mounted under an electric car to make contact with the studs in *Surface Contact Systems*. Usually magnetized in order to actuate the contact mechanism in the stud as the car passes over it.

Contact Spring. A current-carrying spring making contact when required with a fixed or movable rigid contact in such apparatus as telephone jacks, switches, etc.

Contact Spring: Back, Continuity-Preserving, Front, Main, Make-before-Break. See BACK CONTACT, SPRING, CONTINUITY-PRESERVING CONTACT SPRING, etc.

Contact Stud. The knob in the road connected to an underground cable, either permanently or only when a car is passing over it,

from which the current is collected by the skate in *Surface Contact Systems* of traction.

Contact Theory. The theory that the e.m.f. between contiguous dissimilar metals is solely due to their contact.

Contact Wire. See CONTACT LINE.

Contactors. Electro-magnetically, electro-pneumatically or cam operated switches, often provided with magnetic blow-outs and of compact construction, enabling them to be used in groups for the control of traction or other large motors, and operated in the proper sequence by means of a *Master-Controller*, *Push-button* arrangement, etc.; thus avoiding main current connections to the controller itself and enabling one small controller to control a single large unit at a distance or a number of motors through several groups of contactors. See MULTIPLE UNIT CONTROL.

Contactor, Interlocking. See INTER-LOCKING.

Contactor Controller and Contactor Starter. Motor starting and controlling gear employing contactors.

Continuity. The property of a joint in an electric circuit whereby it offers a path of low resistance to a current. See also MAGNETIC CONTINUITY.

Continuity Cable or Rail Bond. A *Bond* between two successive lengths of cable or rail. Cf. CROSS CABLE BOND.

Continuity Fitting. A device for maintaining a conductive connection between adjacent lengths of conduit tube.

Continuity-Preserving Contact Spring. See MAKE-BEFORE-BREAK CONTACT SPRING.

Continuity Rail Bond. A cable or other conducting connection between lengths of conductor or track rail separated owing to crossings or junctions.

Continuous Current. See DIRECT CURRENT.

Continuous Current Balancer. See DIRECT CURRENT BALANCER.

Continuous Current Balancer, Generator, Locomotive, Meter Motor, Traction and Transformer. See

DIRECT CURRENT BALANCE, GENERATOR, etc.

Continuous Electrode. A form of carbon electrode for arc furnaces in which the upper part is continuously renewed by adding material as it is fed forward as the lower part burns away so that the furnace can be worked continuously without intervals for the renewal of electrodes.

Continuous Electrophorus. The name given to the earlier forms of *Influence Machines* acting on the principle of performing the functions of the *Electrophorus* over and over again mechanically.

Continuous Integration. The action of an integrating meter, such as a motor meter, in which the counting gear is being continually driven forward. Cf. *INTERMITTENT INTEGRATION*.

Continuous Loading. A telephone line or cable is said to be continuously loaded when the inductance added to compensate for its capacitance is uniformly distributed throughout its length. Cf. *COIL LOADING*.

Continuous Oscillations. Oscillations which persist with undiminished amplitude and do not consist of short trains of damped swings.

Continuous Rating. The load which a machine, transformer, etc., can deal with continuously for an unlimited time without overheating or other injury.

Continuous Rheostat. A resistance which can be varied smoothly without sudden steps, such as a slide wire resistance or a liquid resistance.

Continuous Running. Conditions of running in a motor, etc., where the load is unvarying and uninterrupted. Cf. *INTERMITTENT RUNNING*.

Continuous Waves. Electric Waves, such as those used in most systems of wireless telegraphy and telephony which persist with undiminished amplitude.

Continuous Waves: Interrupted, Modulated Key-Controlled, Pure, Speech-Modulated, and Unmodulated Key-Controlled. See *INTER-*

RUPTED CONTINUOUS WAVES, MODULATED KEY-CONTROLLED CONTINUOUS WAVES, etc.

Continuous Winding. A term proposed, in view of the confusion between the terms *Multiple* and *Multiplex*, for an armature winding in which the entire winding is traversed in tracing out, before the starting point is reached again. Cf. *DIVIDED WINDING*.

Continuously Integrating Meter. See *CONTINUOUS INTEGRATION*.

Contraction Coefficient. The ratio of the virtual slot width allowing for *Fringing* effect in open or partly closed slots to the true slot width.

Contrast Amplifier. See *NEGATIVE AUTOMATIC VOLUME CONTROL*.

Contrast Photometer. The class of photometer in which two surfaces, illuminated by different sources are contrasted and adjustment of the distances of the sources is made until the illuminations appear equal, e.g. the *LUMMER-BRODRUN PHOTOMETER*.

Control: Automatic Volume, Balance, Brush-shifting, Cascade, Choke, Distance, Electromagnetic, Electro-pneumatic, Field, Gang, Gravity, Grid, Instrument, Krämer, Magnetic, Multiple Unit, Multi-Voltage, Open Circuit, Phonic, Pole-Changing, Potentiometer, Press-Button, Push-Button, Regenerative, Remote, Reversible, Rheostatic, Scherbius, Series-Parallel, Series-Parallel Battery, Series-Parallel Field, Shunted Field, Speed, Sprague, Spring, Star-Delta, Supervisory, Tap-Field, Thermostatic, Tone, Train, Variable Voltage, Volume, and Ward Leonard. See *AUTOMATIC VOLUME CONTROL*, *BRUSH-SHIFTING CONTROL*, etc. See also references under *CONTROLLER* and *LIFT CONTROL*.

Control Board. A switchboard for the *Remote Control* of one or more circuits.

Control Circuit. The circuit which carries the current actuating the *Contactors*, *Reverser*, etc., in an electric train equipment. Cf. *POWER CIRCUIT*.

Control Grid. (1) The particular Grid in a *Thermionic Valve* with more than one grid, used as the *Control*

Electrode. (2) A grid to control the discharge in any form of vacuum, gas or vapour arc tube. Cf. SCREEN GRID and SPACE CHARGE GRID.

Control Electrode (of a *Thermionic Valve*). The electrode to which variable voltage is applied to control the electron stream, i.e. the *Grid*, or one of them if there are more than one.

Control Line (in Electric Traction). A multiple-cored cable all along a train with *Multiple Unit Control* connecting the circuits of all the master controllers.

Control Limit Switch. A *Limit Switch* which opens the control circuit. Cf. MAIN LIMIT SWITCH.

Control Magnet. A magnet used to provide the controlling force to the moving system in instruments.

Control Panel. A panel forming the whole or part of a *Control Board*.

Control Room (in a *Broadcasting Station*). The room which contains the amplifiers and apparatus controlling the output of the microphones before being passed on to the modulation system of the transmitter, including provision for combining the output of several microphones at suitable relative strengths. See MIXING. See also FADE UNIT and MIXING UNIT.

Control System (in a Wireless Transmitter). That part of the equipment which controls the amplification and superposition upon the radio-frequency oscillations of the audio-frequency oscillations from the microphone or incoming line. See also MODULATION SYSTEM.

Control Trailer. A *Trailer coach* in an electric train fitted with a master controller, etc., at one end so that it can be used as the front coach of a train with one or more motor coaches at some other part; e.g. to enable a standard six-car train with two motor coaches, one at each end, to be divided into two three-coach trains which can be driven from either end.

Control Valve. A *Thermionic Valve* in wireless telephony which has the function of amplifying the variations of the microphone speech

currents before they are imposed upon the main oscillating valve circuit.

Controlled Rectifier. See GRID CONTROL.

Controlled Transmitter. A wireless transmitter the frequency of which is kept constant by a special device. See INDEPENDENT DRIVE.

Controller. A conveniently arranged switching apparatus which not only provides for the starting and stopping of a motor, or group of motors, but also controls its speed and sometimes also its direction of motion and can be used for sustained periods on intermediate stops. Cf. MOTOR STARTER.

Controller : Automatic, Barrel, Braking, Cam-Shaft, Contactor, Crane, Drum, Face-Plate, Lift, Master, Multiple Switch, Multiple Unit, Pilot, Potentiometer Braking, Pressure, Reversing, Rheostatic, Rheostatic Braking, Series-Parallel, Solenoid, and Universal. See AUTOMATIC CONTROLLER, BARREL CONTROLLER, etc.

Controller Notches or Positions. See NOTCHES.

Controller Regulator. An automatic device forming part of a traction controller to cut the starting resistance out progressively as the main current drops on each step below a predetermined limit. See AUTOMATIC ACCELERATION.

Convection (Electric). The transfer of electricity by the movement of charged bodies.

Convection, Electrolytic. See ELECTROLYTIC CONVECTION.

Convection Current. The equivalent of a current, produced by a stream of charged particles in rapid movement.

Convection Streams. The streams of electrified particles given off from sharp points on highly charged conductors sometimes called electric *Winds*.

Convective Discharge. Discharge of electricity by the motion of charged particles.

Convector. A name sometimes given to a form of electric heater for rooms in which the heating effect is produced by warming the air as it circulates over the hot

- resistances and not by direct radiation. Cf. **RADIATOR**.
- Convactor Circuit-Breaker.** A type of circuit-breaker using a very small quantity of oil in an *Explosion-Pot* provided with a valve which opens to release the pressure, and provided with an external isolator which opens automatically after the main break.
- Converse Piezo-Electric Effect.** See **PIEZO-ELECTRIC EFFECT**.
- Converter.** A single machine with rotating parts, used to convert direct to alternating current, or *vice versa*, or to alter the pressure of a direct current, or the phase of an alternating current. Cf. **MOTOR-GENERATOR**, **TRANSFORMER**, and **FREQUENCY CHANGER**.
- Converter:** Anode, Auto, Binary, Bragstad, Cascade, "C.M.B.", Frequency, La Cour, Motor, Nine-Ring, Pentagrid, Phase, Rotary, Synchronous, and Turbo. See **ANODE CONVERTER**, **AUTO-CONVERTER**, etc.
- Converting Plant.** Machinery and apparatus, such as that in a substation, for receiving energy in the form of current of one sort and delivering it as current in another form, e.g. converting from *Three-Phase Current* at high tension to *Direct Current* at low tension.
- Converting Station.** A station or substation receiving electrical energy in one form and delivering it in another.
- Convertor.** Alternative spelling of **CONVERTER**. Cf. **STARTOR**.
- Conveyer (Electric).** A conveyer for coal or other substance driven by one or more electric motors.
- Cooker (Electric).** A compact self-contained electric cooking equipment, usually consisting of one or more *Electric Ovens*, and several *Electric Hot-plates*.
- Cooking (Electric).** Cooking by means of apparatus in which the heat is produced when and where required, by passing current through suitable resistances usually buried in the apparatus.
- Cooled Anode Valve.** A *Thermionic Valve* of large size for transmitters, etc., in which the body of the anode is water cooled.
- Coolidge Radiator Tube.** A form of Coolidge Tube without water cooling of the anode, which is fitted with radiating fins.
- Coolidge ("X" Ray) Tube.** A form of powerful "X" Ray tube with incandescent tungsten *Cathode* and water-cooled or air-cooled *Anode* working with a higher vacuum than other tubes, i.e. with gas pressures as low as about 0.003 millionth of an atmosphere, and having a self-rectifying effect which enables alternating current to be used without a rectifier.
- Cooling, Hydrogen.** See **HYDROGEN COOLING**.
- Cooper-Hewitt Lamp.** A form of mercury vapour lamp, usually with a long tube which is tilted automatically or by hand for starting the arc, widely used in photography on account of highly actinic quality of the light produced which is rich in ultra-violet rays.
- Cooper-Hewitt Rectifier.** See **MERCURY VAPOUR RECTIFIER**.
- Cophasal.** Of coincident *Phase*.
- Copper.** The metal most usually employed for electric conductors, on account of its high conductivity, which is only exceeded by that of silver.
- Copper: Deposition of, and Electrolytic.** See **DEPOSITION OF COPPER** and **ELECTROLYTIC COPPER**.
- Copper Brushes.** Brushes for dynamo-electric machinery, made of copper strip, wire, or gauze. Now almost entirely superseded by carbon brushes except for special cases where their higher conductivity is an advantage.
- Copper-Clad Steel Conductor.** A solid conductor for aerial lines with long spans, consisting of steel wire of high tensile strength covered with copper to improve its conductivity.
- Copper-Cored Carbons.** Solid-cored carbons with the core coated with copper to improve the conductivity.
- Copper Factor.** A term used in dynamo design, for the ratio of the actual cross-section of the copper in a winding to the total cross-section including insulation, clearance, etc.
- Copper Loss.** The portion of the

energy losses in dynamo-electric machines, apparatus, circuits, etc., due to heating of the winding, etc., owing to its resistance; proportional to the square of the current multiplied by the resistance, hence sometimes spoken of as $I^2 R$ loss (formerly $C^2 R$ loss).

Copper Oxide Rectifier. See METAL RECTIFIER.

Copper Plating. Deposition of a film of copper on an article by electrolytic means. See DEPOSITION OF COPPER.

Copper Voltmeter. An electrolytic cell used to measure current by weighing the amount of copper deposited on the cathode in a given time.

Coppered Carbons. Arc lamp carbons, electroplated with copper externally to improve their conductivity. Cf. COPPER-CURED CARBONS.

Cord. A flexible cable fitted with plugs on a telephone exchange switchboard provided to make connection with the *Jacks*.

Cord: Flexible, Tinsel, Trolley, Twin Flexible. See FLEXIBLE CORD, TINSEL CORD, etc.

Cord Circuit. The circuit connected to the calling and answering plugs at an operator's position on a telephone exchange switchboard, including the operator's instrument, keys, relays, signal lamps, etc., as well as the cords and plugs.

Cord Circuit, "A" and "B." See "A" CORD CIRCUIT and "B" CORD CIRCUIT.

Cord Circuit Repeater. A telephone repeater, which can be inserted by means of a cord circuit between two lines to improve communication between them.

Cord Grip. A device in the neck of a lamp holder or other apparatus used in connection with flexible cord in which the screwing home of a coned cover tightens up a pair of jaws which grip the cord and take all mechanical strain off the terminals.

Cord Shortener. A device for taking up an extra length of flexible cord in pendants, etc., without cutting it.

Cordless Board. A telephone exchange switchboard in which the

required connections are made entirely by switches and not by plugs and flexible cords. Practically confined to small branch boards.

Core. (1) A mass of magnetic material forming the whole or part of a magnetic circuit, wholly or partly within a coil. (2) See CABLE CORE.

Core: Air, Armature, Cable, Dust, Earthing, Laminated, Magnet, Mass, Pole, Rotor, Slotted, Smooth, Stator, and Transformer. See AIR CORE, ARMATURE CORE, etc.

Core Balance Protective System. A *Protective System* in which lack of balance in the currents in the cores of a three-phase cable, due to a fault, produces a flux in a magnetic circuit surrounding the cable causing a secondary current in a winding thereon which operates a relay.

Core Discs. See ARMATURE CORE DISCS.

Core Loss. The portion of the energy losses in dynamo-electric machinery, transformers, etc., due to hysteresis and eddy currents in the iron core.

Core Plate. The special quality of sheet iron or steel used for laminated machine or transformer cores.

Core Plates. See LAMINATIONS.

Cored Carbons. Arc lamp carbons with one or more cores of softer material than that used for the outer part.

Cored Electrode (in Arc Welding). A *Metal Electrode* in which the flux material is contained in an internal core.

Coreless Armature. An alternator armature, as in certain disc-type machines, without an iron core.

Core-Type Transformer. A transformer constructed with a central iron core over which the coils are wound. Cf. SHELL-TYPE TRANSFORMER.

Corkscrew Rule. A rule for remembering the relation between direction of current and polarity. A *Current* following the direction of twist of a corkscrew produces lines of force in the direction of its thrust. Thus a current in the clockwise or "screwing-in" direction, produces a South Pole facing the

observer as the lines are entering the core.

Corona. The visible luminous discharge which occurs along high tension transmission lines when the diameter of the wire is less than a certain critical figure for the voltage in question.

Corona Loss. The energy loss in high tension transmission lines due to *Corona* discharge.

Corona Voltmeter. An instrument in which high voltages are measured by observing the conditions under which a *Corona* discharge is produced.

Corpuscular Radiation. The emission of those classes of "rays" which consist of the projection of material particles, e.g. *alpha*, *beta*, and *delta* rays.

Correction (in Synchronous Telegraph Systems). The system by which the synchronously running commutators or *Distributors* are kept in phase.

Corrector Circuit. A combination of inductance, capacitance, and resistance used in connection with a long telephone line to counteract distortion due to attenuation not being constant at all frequencies.

Corrosion, Electrolytic. See **ELECTROLYTIC CORROSION.**

Corrugation of Rails. See **RAIL CORRUGATION.**

Cos ϕ (Greek letter "phi"). An expression often used for the *Power-Factor* of a circuit, which is equal to the cosine of the angle of lag between the current and the voltage.

Cosine Law. The law of illumination stating that the intensity of illumination on a surface produced by a given source at a given distance is proportional to the cosine of the angle of inclination at which the light falls on the surface. (Also called *Lambert's Law*.)

Cosmic Radiation or Cosmic Rays. Radiation of even shorter wavelength than *Gamma Rays* and of great penetrating power, which can be detected particularly at high altitudes by the ionization which they cause, also called *Ultra-Gamma* and *Penetrating Radiation* or *Rays*. Thought by some to orig-

inate in the upper atmosphere and by others to be of extra-terrestrial cosmic origin and variously explained as due to disintegration of atoms or to radiation due to the shock of the recreation of matter from radiation.

Cotton Covered Wire. Wire for electrical purposes covered with one or more layers of spun cotton yarn.

Coulomb (C). A "practical" unit of quantity of electricity (named after C. A. de Coulomb, 1736-1806), being the quantity which has passed when one ampere has flowed for one second, i.e. 10^{-1} absolute C.G.S. electromagnetic units, at one time called the *Weber*. For engineering purposes the ampere-hour is more commonly used. (One *Ampere Hour* = 3,600 coulombs.) See also **FARADAY**.

Coulombmeter. An electricity meter or other instrument, often of the *Voltmeter* type, which measures quantity of electricity only, irrespective of the voltage.

Coulombmeter, Gas. See **GAS COULOMBMETER.**

Coulomb's Law. The mechanical force between two charged bodies is directly proportional to their charges and inversely proportional to the square of the distance between them.

Coulometer. Contraction of *Coulombmeter*, sometimes used to signify a *Voltmeter*.

Counter, Spark. See **SPARK COUNTER.**

Counter-Compound Winding. See **DIFFERENTIAL COMPOUND WINDING.**

Counter-Electromotive Force. See **BACK ELECTROMOTIVE FORCE.**

Counter-E.M.F. Cell. A cell, with the plates connected up the reverse way, sometimes introduced into an accumulator battery for regulating purposes.

Counterpoise. A substitute for a conductive earth connection to a wireless aerial, consisting of a considerable area of metal sheet or net spread over the ground or supported clear of it, and serving as one plate of a large capacitor on which the earth is the other: or, in the case of aircraft, of a system of wires on the frame of the machine.

(Also called *Balancing Capacitance*, *Capacitance Earth and Lower Capacitance*.)

Couple, Magnetic and Thermo or Thermo-Electric. See MAGNETIC COUPLE and THERMO-ELECTRIC COUPLE.

Coupled Circuits. See COUPLING.

Coupled Switches. See LINKED SWITCHES.

Coupler. (1) A device of the plug and socket nature for connecting cables, etc., as between coaches on electric trains. (2) A short plain or screwed sleeve for making a straight-through joint between lengths of conduit tube for wiring. (3) Any device for the coupling of circuits.

Coupler: Bus-Line, Condenser, Piezo-Electro, Potential, Running, and Screwed. See BUS-LINE COUPLER, CONDENSER COUPLER, etc.

Coupler Plug. A plug on a jumper cable, such as that between coaches on an electric train.

Coupler Socket. A socket at the end of a coach on an electric train for the reception of a *Coupler Plug*.

Coupling (of Circuits). Any method of associating circuits so that energy can be interchanged between them.

Coupling: Auto-Capacitative, Auto-Inductive, Cable, Capacitive, Capacitance, Centrifugal, Coefficient of, Conductive, Choke, Choke-Capacitance, Electromagnetic, Electrostatic, Inductive, Insulating, Loose, Normal, Resistance, Resistance-Capacitance, Reversed, Tuned-Anode, and Variable. See AUTO-CAPACITATIVE COUPLING, AUTO-INDUCTIVE COUPLING, etc.

Coupling Coefficient (of two Oscillating Circuits). The ratio of the difference to the sum of the squares of their resonant frequencies. Symbol: k .

Coupling Error (in Wireless Direction Finders). A slight error due to the magnetic coupling of the field and search coils not following an exact cosine law owing to the spread of the windings.

Coupling Factor. The figure taking into account the constants of two coupled circuits which determines the rate of transfer of energy between them. In the case of

inductive coupling, the ratio of their mutual inductance to the geometric mean of their respective self inductances. See also CAPACITATIVE COUPLING.

Covered Electrode (in Arc Welding). A metal electrode with a cover composed of flux material.

Course-Indicating Radio Beacon. A *Radio Beacon* giving characteristic signals in certain definite directions only. Cf. OMNI-RADIO BEACON.

Cowles Furnaces. An early form of *Electrolytic Furnace* for manufacturing aluminium alloys, in the form of a long trough with carbon electrodes at the ends.

C.P. Abbreviation for *Candle Power*.

OR Law (formerly known as KR Law).

The law established by Lord Kelvin relating to the propagation of current in submarine cables to the effect that the time required for a received current to reach a stated fraction of its maximum value is proportional to OR^2 , where C = capacitance, R = resistance, and l = length.

C.R. Tests of Cables. Tests of Copper Resistance. Cf. D.R. and D.K.

Crack Detector, Electromagnetic. See ELECTROMAGNETIC CRACK DETECTOR.

Cradle, Guard. See GUARD CRADLE.

Crane (Electric). Electric cranes are either provided with a separate motor for each of the various motions such as lifting, slowing, traversing and travelling, or a single motor is used with suitable gear.

Crane Controller. A controller for operating the motor or motors of an electric crane.

Crane Magnet. See LIFTING MAGNET.

Crane Motors. Motors of the special type made for *Crane* driving; usually similar in design to traction motors and series or compound wound if for direct current.

Crane Rating. The method usually employed in stating the power of crane motors and others for intermittent working, by giving the power which they can develop at a certain load factor.

Crater. The portion of the tip of the positive carbon in a direct current arc lamp which becomes hollowed out and by which

the greater part of the light is emitted.

Crawling. The refusal of an induction motor, when the attempt is made to start it up, to run above about one-seventh (or other sub-multiple) of full speed, owing to the presence of a pronounced seventh or other harmonic in the field form.

Creed Printing Telegraph System. A system of type-printing telegraphy in which the message is first punched in the ordinary Morse code on a paper strip and put through an instrument similar to the Wheatstone transmitter. The received signal currents actuate through relays a punching instrument which reproduces the original strip. This is then passed through the printer, where a mechanical selecting device depending upon the alignment of holes in a pile of strips displaced according to the position of the holes in the punched strip, causes the right letter to be printed by a typewriter mechanism. In some of the later forms, the five-unit alphabet replaces the Morse alphabet.

Creed Receiving Perforator. The instrument in the Creed printing telegraph which punches the strip at the receiving end.

Creed Translator. An instrument which when supplied with an ordinary Wheatstone perforated strip, punches a second strip with the corresponding signals in the form required for cable transmission by mirror instrument or siphon recorder.

Creep (of an Armature Winding). The displacement through the field between the beginning and end of an armature winding.

Creeping. See SHUNT RUNNING.

Creeping, Magnetic. See MAGNETIC CREEPING.

Creeping Distance. The length of the leakage path over the surface of insulating material on which damp or dirt may collect.

Creep Factor. See PEAK FACTOR.

Crest Values. See PEAK VALUES.

Crest Voltmeter. An instrument for measuring the maximum value of an a.c. voltage. In one form this

is done by measuring the rectified charging current to a condenser by a moving coil galvanometer.

Crest Voltmeter, Neon Tube. See NEON TUBE CREST VOLTMETER.

Crinoline. An arrangement of rings in a cable tank to prevent the cable kinking as it is paid out.

Critical Damping. Damping which is just sufficient to remove oscillations.

Critical Pressure. The pressure, or voltage, at which a corona discharge just begins to take place under given circumstances of size of wire, etc.

Critical Resistance. (1) The minimum resistance of the external circuit at which a shunt-wound dynamo will excite or will maintain stable excitation. (2) The maximum resistance which a circuit of given inductance (L) and capacitance (C) must have for it to be possible for it to have a natural period of oscillation, equal to $2\sqrt{L/C}$. See OSCILLATING CIRCUIT.

Critical Span. The length of span for which, for a particular size of wire, the tension produced by the worst assumed conditions of load combined with the average conditions of temperature is the same as that produced by the worst conditions of temperature combined with average conditions of load.

Critical Speed. The speed at which the natural free period of oscillation of the rotating system of a turbo-generator coincides with the speed or a multiple thereof so that excessive vibrations are liable to be produced.

Critical Temperature. The temperature at which magnetic materials lose their magnetic properties; for iron and most steels, in the neighbourhood of 800°C ., for nickel about 300°C . See also HEUSLER ALLOYS.

Critical Voltage. The voltage above which corona discharge appears under particular conditions or diameter of wire, etc.

Crookes Dark Space. The non-luminous space in a vacuum tube which separates the *Negative Glow* from the cathode at gas pressures below about $1/2000$ of an

atmosphere. Also called *Cathode Dark Space*. Cf. FARADAY DARK SPACE.

Crookes Tube. A vacuum tube sufficiently highly exhausted for the *Crookes Dark Space* to fill the tube and the phenomena of cathode rays to be observed: i.e. with a gas pressure below about 1/10,000 of an atmosphere. Named after Sir William Crookes.

Cross, Thermal. See THERMAL CROSS.

Cross Ampere-Turns. The component of the armature ampere-turns which tends to produce a field at right angles to the main field.

Cross Arms. The horizontal arms attached to telegraph, telephone or transmission line poles, which carry the insulators.

Cross Cable or Rail Bond. A conducting bond connecting adjacent cables or rails. Cf. CONTINUITY CABLE BOND.

Cross-Connecting Board. An old-fashioned form of switchboard in which connections were made by plugs and sockets. Particularly an arc lighting board formerly common in America.

Cross Connections. Connections by which the commutator segments a pole pitch apart are connected, in order that one pair of brushes may be used for a multipolar lap-wound armature. (Also used to signify *Equipotential* or *Equalising Connections*.)

Cross-Connection Field (in Telephony). A space in a distribution frame through which connection can be made by jumper wires between sets of terminals in a different order on the two sides.

Cross-Field or Cross Flux. The magnetic flux at right angles to the main flux produced by the portion of the armature ampere-turns. See CROSS AMPERE-TURNS.

Cross Modulation. The effect of curvature in the amplification characteristic of a radio-frequency amplifying valve, due to secondary emission from the screen-grid in decreasing the selectivity when a frequency for which the circuit is tuned is present.

Cross Span Suspension. See SPAN WIRE SUSPENSION.

Cross Span Suspension, Catenary and Single. See CATENARY CROSS SPAN SUSPENSION and SINGLE CROSS SPAN SUSPENSION.

Cross Talk. Inductive interference between separate circuits in a telephone cable. Cf. OVERHEARING.

Cross Talk Measurement. An instrument for estimating the tendency of one telephone circuit to cause cross talk in another by measurement of current induced in the disturbed circuit by a standard vibrator of lead to the disturbing circuit, or otherwise.

Crossed Coil Instruments. Instruments such as certain forms of *Ohmmeter* in which the ratio of the current flowing in coils at right angles to each other is indicated by the direction of the resultant field.

Crossing, Overhead. See OVERHEAD CROSSING.

Cross-Jet Circuit-Breaker. A form of *Oil-Blast Circuit-breaker* in which the oil jet is directed across the arc.

Crown of Cups. The name originally given to the simple battery of Volta with its several cells (cups) in series.

Crown Rail Bond. A *Rail-bond* of flexible copper cable with solid terminals expanded into the hole in the rail by drift pins.

Crucible Furnace. A type of *Resistance Furnace* in which the crucible itself, which is of graphite or other conducting material, forms the heating element, e.g. *Canley* and *Halberger Furnaces*.

Cryptadyne Reception. A system of wireless reception in which *Bigrid Valves* are used to reduce the number of valves required by combining the functions of two valves in one.

Cryptometer, Photoelectric. See PHOTOELECTRIC CRYPTOMETER.

Crystal Control. See CRYSTAL DRIVE.

Crystal Detector. A detector of electric waves used in wireless telegraphy depending upon the unidirectional conductivity of a contact between a crystal and another substance: used in a suitably tuned circuit without a battery in series with a telephone receiver

in which the successive rectified oscillations produce a cumulative effect on the diaphragm and become audible.

Crystal Detector, Permanent. See PERMANENT CRYSTAL DETECTOR.

Crystal Drive. A method of *Independent Drive* in a wireless transmitter employing a *Piezoelectric Oscillator* to control the frequency.

Crystal Receiver or Crystal Set. A simple receiving set for wireless telephony, etc., consisting of a *Crystal Detector* in series with a telephone in a tuned aerial circuit.

Crystodyne Reception. A system of wireless reception employing a crystal detector polarised by a battery which gives it the property of negative resistance, enabling it to be used somewhat like a thermionic valve for amplification, reaction, etc.

Cubicle. A chamber for the accommodation of an item of high-tension switchgear separating it by a fireproof partition from apparatus at a widely different potential.

Culvert. A covered underground trough in which cables are laid.

Cumulative Compound Winding. A compound winding in which the series and shunt coils produce a field in the same direction, as opposed to a *Differential Winding*.

Cumulative Grid Rectification. Rectification by a thermionic valve depending upon the unidirectional conductivity between the grid and the cathode. A small condenser is included in the grid circuit which allows a small negative potential to build up on the grid, due to excessive high-frequency oscillations but provided with a *Grid Leak* to prevent it reaching a value which would prevent grid current from passing. Also called *Grid Leak Rectification*. Cf. ANODE BEND RECTIFICATION.

Cuprox Rectifier. See METAL RECTIFIER.

Curb Transmission. Methods of telegraph transmission ensuring a sharp end to a signal current in a long submarine telegraph cable to improve the speed of signalling by sending at the end of each

signal a "curb" current in the opposite direction, or by a suitable arrangement of condensers.

Curie Constant. The coefficient of magnetisation of a material multiplied by the absolute temperature.

Curie Effect. A lowering of temperature which takes place in a *Paramagnetic* substance, when a magnetic field to which it has been subjected has been removed.

Curie Point. The *Critical Temperature* at which ferromagnetic quality disappears.

Curie's Law. The susceptibility of a paramagnetic body or of a ferromagnetic body above its critical temperature at a given magnetising force is proportionate to the absolute temperature.

Current (Electric). The passage of electricity through a body by conduction, i.e. by a drift of negative electrons through the body in one direction. Usually measured by the practical unit, the Ampere, which is one tenth of the Absolute or C.G.S. Electro-magnetic Unit (the current which when flowing in a circular path 1 cm. in radius, exerts a force of 1 dyne for every cm. of its length upon unit magnetic pole at its centre.) Symbol *I* (formerly *C*).

Current: Absorption, Action, Aerial, Alternate, Alternating, Anomalous, Charging, Anomalous Conduction, Anomalous Discharge, Audibility, Balanced, Blind, Blowing, Breaking, Carrying, Capacitance, Charging, Circulating, Conduction, Constant, Continuous, Convection, D'Arsonval, Diaphragm, Direct, Discharging, Displacement, Earth, Eddy, Effective, Equalising, Exciting, Extra, Faradic, Feed, Field, Foucault, Fusing, Galvanic, Grid, High-Frequency, Idle, Induced, Interchange, Intermittent, Interrupted, Inverse, Ionic, Ionisation, Leading, Magnetising, Making, Marking, Negative, No-Load, Normal, Normal Charging, Normal Conduction, Normal Discharge, Oscillating, Oscillatory, Oudin, Out-of-Balance, Parasitic, Plate, Polyphase, Positive, Primary, Pulsating, Reactive, Rectified, Residual, Return,

Reversal of, Reverse Grid, Ringing, Root Mean Square, Rotary, Running, Saturation, Shaft, Short-Circuit, Sine, Single-Phase, Sinoidal, Six-Phase, Sneak, Space, Spacing, Speaking, Spill, Starting, Static Induced, Static Wave, Steady, Stray, Superimposed, Superposed, Superposed Ringing, Synchronising, Tesla, Thermionic, Thermoelectric, Three-Phase, Transient, Two-Phase, Undulatory, Unidirectional, Vagabond, Vertical, Wattful, and Wattless. See ABSORPTION CURRENT, ACTION CURRENT, etc.

Current Carrying Capacity. The current which a conductor can carry without undue heating or potential drop.

Current Circuit (of a Motor, etc.). The heavy circuit in a wattmotor, watt-hour meter, etc., carrying the main current. Cf. VOLTAGE CIRCUIT.

Current Collector. The device attached to a vehicle which makes contact with the *Contact Line* or *Contact Rail*. See TROLLEY, BOW COLLECTOR, PANTAGRAPH COLLECTOR, CONTACT SHOE and PROUGH.

Current Density. The current in amperes per unit of cross section, e.g. square inch, flowing in a conductor, or per sq. ft. in an electrolyte.

Current Efficiency (in an Electrochemical Process). The ratio of the substance chemically acted upon to that according to *Faraday's Law*.

Current Impulse. See IMPULSE.

Current Indicator. See AMMETER.

Current Limiter. An instrument, used in connection with some systems of charging for electricity supply, which gives a signal by intermittent interruptions of the current, causing a flickering of the lamps, when the current exceeds a specific maximum.

Current Limiting Inductor, or Reactor. An inductor or choking coil placed in any part of a circuit to limit the possible fault current therein.

Current Sheet. A current flowing in a broad sheet of conducting material, whether uniformly distributed or otherwise.

Current Square Meter. A *Hot-Wire*

or other type of *Ammeter* calibrated so that the readings indicate the square of the current.

Current Transformer. A transformer with its primary in series with the main circuit and its secondary connected to the terminals of an ammeter or other measuring instrument, relay, etc., and delivering to it a current at a low c.m.f. proportional to that in the main circuit; thus avoiding connection of either heavy-current or high-potential leads to the instrument itself. Cf. VOLTAGE TRANSFORMER.

Current Transformer: Bar Type. Bushing, D.C., Multiturn, Open-Primary, Single-Turn, Straight, Straight-through, and Stud. See BAR TYPE CURRENT TRANSFORMER, BUSHING CURRENT TRANSFORMER, etc.

Current Weigher. An instrument for the accurate measurement of current by balancing the attraction between fixed and movable current carrying coils against gravity.

Curve: Arrival, B-H, Characteristic, Demagnetisation, Hysteresis, Load, Magnetisation, Residue, Resonance, Saturation, Sine, and Tuning. See ARRIVAL CURVE, B-H CURVE, etc.

Curve Tracer (Ewing's). An instrument for throwing *Hysteresis Curves* upon a screen, in which a centrally pivoted mirror is deflected horizontally in proportion to the magnetising force, by the movement of a wire carrying the magnetising current in a constant field, and in a vertical direction in proportion to the induction, by the movement of a wire carrying a constant current in an air-gap in the magnetic circuit in question, while cycles of magnetisation are being carried out.

Cut-Off Frequency. The frequency above or below which the attenuation of a circuit (e.g. a *Loaded Cable* or a piece of apparatus, e.g. a *Microphone*) rises rapidly.

Cut-Off Relay. The relay in the connections to a subscriber's line on a telephone switchboard which causes the extinction of the *Calling Lamp*, by disconnecting

the *Line Relay* when the operator inserts the *Answering Plug*.

Cut-Out. An apparatus for opening a circuit automatically under abnormal conditions; usually confined to the smaller classes of *Automatic Circuit-Breakers* and *Fuses*, and sometimes limited to fuses only.

Cut-Out: Automatic, Battery, Discriminating, Double Pole, Fusible, Immersed Liquid-quenched, Liquid-quenched, Oil-quenched, Magnetic, Maximum, Minimum, Plain, Plug, Protected, Reverse Current, Semi-enclosed, Semi-immersed liquid-quenched, Series, Single-Pole, and Thermal. See *AUTOMATIC CUT-OUT, BATTERY CUT-OUT*, etc.

Cut-Out Board. See *DISTRIBUTION FUSE BOARD*.

C.W. Abbreviation for *Continuous Waves*.

"C" Wire (in Telephony). See *"S" WIRE*.

Cyanamide Process (of Fixation of Nitrogen). In this process carbide is first made by heating lime and coke in an electric furnace, and is then made to absorb atmospheric nitrogen to form cyanamide (CaNCN). Electric heating is only required to start this reaction. Cyanamide is employed as a fertiliser, and is also used to make ammonia by treatment with steam. Cf. *SYNTHETIC AMMONIA*.

Cyc-Arc Welding. An arc welding system for attachment of studs, etc., to steel plates, in which the stud is held in a welding tool clamped or magnetically fixed to the work, and is automatically touched against and withdrawn from the plate to strike an arc and then firmly pressed against it to complete the weld.

Cycle. The changes completed during a complete *Period*, including two half-waves in opposite directions, in an alternating current, voltage, etc. See *FREQUENCY*.

Cycle, Rayleigh. See *RAYLEIGH CYCLES*.

Cycle of Magnetisation. The complete operation of magnetising and demagnetising a body gradually first in one direction and then in the other.

Cyclic Irregularity. The percentage variation of speed from the normal of an engine driving an alternator, during one revolution.

Cyclogram. A record obtained from a *Cyclograph*.

Cyclograph. A name sometimes given to an instrument with an optical or *electron-jet* "pointer" moving in two dimensions under control respectively of different variables (to distinguish it from a true *Oscillograph* in which the pointer moves in only one dimension under control of a single variable while the time element is taken into account by movement of the screen or otherwise). In the case of regular periodic functions a closed figure or *Cyclogram* similar to one of *Lissajous Figures* is produced.

Cyclometer "Dials." The indicating portion of an integrating meter, consisting of changing figures appearing at apertures, instead of index fingers moving over graduated dials.

Cylinder Electrical Machine. A "*Frictional*" *Electrical Machine* in which a rotating cylinder of glass or other dielectric rubs against fixed cushions. Cf. *PLATE ELECTRIC MACHINE*.

Cylindrical Rotor. A *Rotor* of a generator, motor, etc., in which the winding is evenly distributed in slots, as in the ordinary induction motor. Cf. *SALIENT POLES*.

Cylindrical (Transformer) Winding. A winding employed for moderate voltages in one or more layers of considerable length relatively to the diameter.

Cymometer (Fleming's). An instrument for measuring the frequency of electric waves, in which a capacity formed by one brass tube sliding over another can be varied simultaneously with an inductance consisting of a solenoid of bare wire, and arranged so that the *Oscillation Constant* at which resonance takes place, as indicated by the glowing of a *Neon Tube*, can be read off on a scale.

Cymoscope. A detector of electric waves.

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D. Symbol in *Flux density* (electric) and *Displacement*.

Damped Oscillations. Oscillations which rapidly decrease in amplitude and die away.

Damped Waves. Waves produced by *Damped Oscillations*, as employed in spark systems of wireless telegraphy. Sometimes called *Type B Waves*.

Damper. An electrical or mechanical device for dissipating energy which if unchecked would cause mechanical or electrical oscillations. See AMORTISSEUR, DAMPING MAGNET, DASH-POT, etc.

Damper Winding. See AMORTISSEUR.

Damping. (1) Dissipation of energy in an electrical or mechanical oscillating system, causing progressive diminution and, if continued, ultimate extinction of the oscillations. (2) The ratio of the amplitude of one swing in damped oscillations to that of the next, in the opposite direction. See also LOGARITHMIC DECREMENT.

Damping: Critical, Magnetic, and Specific. See CRITICAL DAMPING, MAGNETIC DAMPING, etc.

Damping Coil or Grid. Short-circuited coils in any electrical apparatus for the purpose of causing damping by the reaction of induced currents therein, e.g. a short-circuited coil or grid in the pole face of an a.c. machine to improve parallel running and to lessen armature reaction.

Damping Factor. If $As^{-bt} \sin cot$ denote a damped oscillation, s^{-bt} is called the "damping factor" where T is the periodic time.

Damping Grid. See DAMPING COIL.

Damping Magnet. A permanent magnet used to produce a damping force by inducing currents in a metal disc, drum, etc., to check the oscillations of the moving

system of an instrument. Sometimes wrongly used for the *Brake Magnets* of a motor which provide a retarding force.

Damping Ring. A metallic ring in which odd currents are produced for damping purposes.

Damping Winding. See DAMPING COIL.

Dancing Spiral, Roget's. See ROGET'S DANCING SPIRAL.

Daniell Cell. A primary cell of the double-fluid type, with zinc and copper electrodes and a depolariser of copper sulphate. Formerly widely used in telegraphy.

Daraf. The name suggested for the practical or *M.K.S. Unit of Elastance*, i.e. the reciprocal of the *Farad*.

Darimont Cell. A double-fluid primary cell with zinc and carbon electrodes, a depolariser of ferric chloride and an excitant of calcium carbonate and sodium chloride.

Dark Discharge. The very slight discharge which can take place through air or other gases at atmospheric pressures and temperatures at voltages insufficient to cause a visible glow or *Corona*.

Dark Space: Cathode, Crookes's and Faradays'. See CATHODE DARK SPACE, CROOKES'S DARK SPACE, etc.

D'Arsonval Current. A term used in connection with *Diathermy* for a heavy current at a low voltage. Cf. QUIDIN CURRENT and TESLA CURRENT.

D'Arsonval Galvanometer. A galvanometer in which a suspended coil carrying the current to be measured is deflected in a fixed magnetic field.

D'Arsonvalism. See HIGH FREQUENCY TREATMENT.

Dash-Pot. A vessel in which a piston or vane of some kind moves in oil or air which can only pass through constricted channels so as

to give a damping or retarding action. Used in indicating instruments to make them *Dead-Beat*, and in arc-lamp mechanism and switchgear.

Daylight Lamp. A lamp arranged to give light with a spectral composition approximating as nearly as possible to that of daylight for colour matching, picture lighting, etc., consisting usually of a *Gas-Filled Lamp* either in a bulb of special coloured glass or used in conjunction with special coloured screens which absorb the excess or rays at the red end of the spectrum. See also *SHERINGHAM DAYLIGHT LAMP*.

D.B. The usual abbreviation for *Double Break*.

Db. Abbreviation for *Decibel*.

D.C. The usual abbreviation for *Direct Current*.

D.C. Current Transformer. An appliance in which the main current magnetizes a core surrounding the conductor or enclosed by a few turns of it, in the air gap of which is an armature driven at a constant speed provided with brushes connected to the indicating instrument.

Dead. A conductor or circuit is said to be "dead" when it is unconnected to a source of e.m.f. Cf. *ALIVE*.

Dead Beat. An indicating instrument is said to be "Dead Beat" when it takes up its reading at once without oscillations, i.e. when it is *Critically Damped*. Cf. *APERIODIC*.

Dead Coil. An armature coil which does not contribute its e.m.f. to the external circuit, either because it is short-circuited or disconnected, or is only present for the sake of symmetry and is not connected to the commutator.

Dead Earth. An accidental connection to earth of very low resistance.

Dead End Effect (in Wireless Telegraphy, etc.). The effect in an oscillating circuit of the self capacitance of idle turns in an inductance tapped from an intermediate point which may cause considerable energy loss.

Dead End Switch. A multiple contact switch for making contact to various intermediate points in a coil, etc., and cutting out the remainder to avoid *Dead End Effect*.

Dead End Tower. A Tower used at the end of an overhead line, designed to take the pull of all the conductors as well as the other usual stresses.

Dead Ended Feeder. See *INDEPENDENT FEEDER*.

Dead Front Type Switchboard. A switchboard with all live parts behind the panels, which may be of sheet iron.

Dead Man's Handle. A controller handle for electric trains which automatically breaks the circuit and applies the brakes if the driver releases his hold upon it. Used as a safety device where the driver is not accompanied by another man.

Dead Segment. (1) A commutator segment which has become disconnected from the armature winding. (2) A segment unconnected to any coil but connected to the adjoining segments of a high resistance to improve commutation.

Dead Short. Colloquial expression for an accidental short circuit of very low resistance.

Dead Space. See *ZERO BEAT*.

Deafeners. Devices used to avoid the hum of telephone wires, etc., such as strips of lead wound round them on each side of the insulator.

Death Ray. A popular name for the powerful rays for which great destructive effect is claimed by inventors of secret methods for their production. They are reported to be of wave-lengths on the border land between ultra-violet light and "X" Rays, and to be produced in concentrated beams. The claims made have not received satisfactory experimental confirmation.

Decay Coefficient or Decay Factor. A term sometimes used for the logarithmic decrement per unit time in damped oscillations. Symbol: α .

Decentralisation (in Cables). The accidental shifting of the position of the cores in cables with bitumen and similar insulation due to the softening of the insulation by heat, etc., causing insufficient thickness of insulation on one side with consequent risk of breakdown.

Deci-. Prefix signifying one-tenth.

Deci-Ampere Balance. A Kelvin *Current Balance* with a range from 0.1 to 10 amperes.

Decibel. See TRANSMISSION UNIT.

Decibel Meter. An instrument for measuring acoustic response in the form of a thermionic voltmeter in which advantage is taken of the fact that a screen grid valve can be adjusted to possess an approximately exponential anode-grid current characteristic.

Decimal Candle. See BOUGIE DECIMALE.

Declination. The angular deviation of a magnetic needle or compass, uninfluenced by local causes, from true North and South at any point on the earth's surface; different at different places, and varying at different periods.

Declinometer. An instrument for measuring accurately the angle between the magnetic meridian and the geographical meridian.

Decohere. A coherer is said to "decohere" when it resumes its normal feebly conducting state on tapping or disturbance, after it has been made conducting by electrical oscillations, etc. See COHERER.

Decomposition Voltage. The minimum voltage which will cause chemical change in an electrolytic cell.

Decompounding Winding. A series winding in a continuous-current machine connected so as to oppose the shunt winding and to diminish the field as the load rises.

Decorative Lamps. Lamps used not with a view to improving the useful illumination, but solely for decorative effect, either for providing steady, flickering, or moving points of light, or for illuminating surfaces to give a pleasing effect or to show off architectural detail.

Decorative Lighting. See DECORATIVE LAMPS.

Decrement. See LOGARITHMIC DECREMENT.

Decrement: Equivalent Logarithmic, Lineal, and Logarithmic. See EQUIVALENT LOGARITHMIC DECREMENT, LINEAL DECREMENT, etc.

Decremeter. An instrument by which the *Equivalent Logarithmic Decrement* of waves can be measured by comparison of the resonance current in a tuned circuit with that in a circuit out of tune by a known percentage, or otherwise.

Deep Sea Cable. The lightest of the three types of submarine telegraph cable; without external armouring. Cf. INTERMEDIATE and SHORE-END CABLES.

Definite Time Lag, Time Element, or Time Limit. A Time Lag arrangement in a circuit-breaker, etc., whereby the time elapsing between the attainment of the specified conditions and the coming into action of the apparatus is constant when once adjusted independently of the magnitude of the overload, etc. Cf. INVERSE TIME LAG.

Deflection. The angular displacement of the moving part of an instrument such as a galvanometer, ammeter, voltmeter, etc., from its zero position, which indicates the magnitude of the quantity to be measured; or, in general the displacement of anything by an external force such as that of an arc or other electron stream by a magnetic field.

Deflection Potentiometer. A form of *Potentiometer* in which the potential drops across the resistance are not balanced exactly to bring the galvanometer to zero, but the difference is indicated by its deflection.

Deflection Plates. Electrodes of varying potential provided to effect the deflection of the beam in a *Cathode Ray Oscillograph*.

Deflector, Arc. See ARC DEFLECTOR.

De Forest Coil. See HONEYCOMB COIL.

De Forest System. A system of wireless telegraphy chiefly distinguished by the employment of one of the detectors invented by L. De Forest, such as his electrolytic detector

or the *Audion*, which was an early form of the three-electrode thermionic valve tube.

Degrees (Electrical). The position of a point in the wave of an alternating current, etc., or of an armature conductor, etc., in the angle embraced by a pair of poles is often expressed in "degrees" reckoning the whole cycle or double pole-pitch as 360° . This is tantamount to reducing the case to that of a two-pole machine. Such degrees are spoken of as "electrical" degrees to distinguish them from degrees measuring actual angles in space.

Deion Circuit-Breaker. A form of circuit-breaker in which the arc, on breaking, is magnetically blown into a stack of insulated copper plates so that the effect is that of a great number of short arcs in series. Each gap becomes almost instantly deionised at the current zero and re-formation of the arc is prevented.

Deionisation. The reduction of a mass of gas, which has been made conducting by becoming ionised, to its previous non-conducting state. There are a number of ways, including cooling, diffusion, absorption, an air blast or a magnetic field, by which a spark gap in wireless telegraphy can be rapidly deionised, in order to prevent an arc following it. See **QUENCHED SPARK**, **ACTIVE SPARK**, and **ARCING SPARK**.

Deka-. Prefix signifying ten times.

Deka-Ampere Balance. A Kelvin *Current Balance* with a range from 1 to 100 amperes.

Delaney Multiplex (Telegraph) System. One of the earlier forms of *Multiplex* telegraph systems depending upon synchronously revolving commutators at the sending and receiving ends of the line.

De la Rue Cell. See **CHLORIDE OF SILVER CELL**.

Delay Action Circuit-Breaker, Relay, etc. See **TIME ELEMENT**, etc.

Delayed Automatic Volume Control. *Automatic Volume Control* which does not begin to come into action until a certain signal strength is attained, in order to prevent undue

magnification of background noise while the tuning control is passing from one station to another. Also called *Quiet Automatic Volume Control* or *Suppressed Automatic Volume Control*.

Delon Rectifier. A rectifier employed in *Electroculture* and for other purposes consisting of a system of condensers in conjunction with a mechanical revolving switch.

Delta Connection. Connection of a three-phase system so that the phases form a triangle, as opposed to *Star* connection in which they form a star with a neutral point. Cf. **MESH CONNECTION**.

Delta (δ). Symbol for *Logarithmic Decrement*.

Delta (δ) Rays. A class of rays emitted by radio-active substances consisting of the projection of negatively charged corpuscles at a much slower speed than that in the case of β rays. (Cf. α and γ RAYS.)

Delta Voltage. The *Line Voltage* of a three-phase system, or that between alternate lines in a six-phase system, i.e. one side of one of the two interlacing triangles by which the system may be represented. Cf. **MESH VOLTAGE**, **DIAMETRAL VOLTAGE**, and **STAR VOLTAGE**.

Demagnetisation. The returning of a magnetised body to the unmagnetised state, or any action tending to reduce its degree of magnetisation.

Demagnetisation, Self. See **SELF-DEMAGNETISING FORCE**.

Demagnetisation by Continued Reversals. A convenient method of removing the magnetisation from a body by subjecting it to gradually decreasing cycles of magnetisation, e.g. by gradually reducing the magnetising current to zero while it is being continually reversed, or spinning the object round while gradually drawing it out of a strong field.

Demagnetisation Curve. A curve of Flux Density (B) plotted against magnetising force (H) for a sample of steel showing the reduction of magnetisation by the reduction and subsequent reversal of the magnetising force.

Demagnetisation of Watches. A

- watch damaged by magnetisation can be restored to its original state by spinning while it is being gradually withdrawn from a strong magnetic field or by being introduced and gradually withdrawn from a solenoid carrying an alternating current. See **STRAY FIELD**, **MAGNETISED WATCH**, and **NON-MAGNETIC WATCH**.
- Demagnetising Turns.** See **BACK AMPERE-TURNS**.
- Demand Indicator.** See **MAXIMUM DEMAND INDICATOR**.
- Demand Limiter.** See **CURRENT LIMITER**.
- Demand Printer.** See **PRINTOMETER**.
- De Meritens Alternator.** An old form of alternator in which the field is produced by a number of permanent horseshoe magnets mounted on a revolving frame. Used until recently in some of the older light-house equipments.
- Demodulation.** The action of the receiver in *Wireless* or *Carrier Current Telephony*, in disentangling and responding to modulations superimposed upon the carrier current or wave.
- Demountable Valve.** A high power wireless transmitting valve in a metal container with porcelain insulation, which can be taken to pieces for inspection and renewal of the electrodes and re-exhausted.
- Demultiplier, Frequency.** See **FREQUENCY DEMULTIPLIER**.
- Density, Current, and Flux.** See **CURRENT DENSITY** and **FLUX DENSITY**.
- Density of Charge.** Electrostatic charge per unit area.
- Depilation (Electric).** Removal of superfluous hair by electrolytic methods.
- Depolarisation.** Prevention of the back e.m.f. of *Polarisation* liable to be produced in some primary cells; usually by providing an oxidising agent to act upon the hydrogen as fast as it is produced on the positive electrode, or arranging that some other substance, such as copper, is deposited instead of hydrogen.
- Depolarisation, Mechanical.** See **Mechanical Depolarisation**.
- Depolariser.** A chemical agent employed to effect *Depolarisation*, such as bichromate of potash or peroxide of manganose.
- Deposit.** (1) A coating of metal electrolytically deposited upon any material. (2) The sediment found at the bottom of an accumulator cell.
- Deposition, Electro-.** See **ELECTRO-DEPOSITION**.
- Deposition of Copper.** Depositing copper by electrolytic means in the form required, e.g. copper plating, electrotyping, electrolytic manufacture of copper tubes, etc., and purification of copper by the electrolytic process.
- Depressed Conductor Rail.** A portion of a conductor rail below the ordinary level where it is not desired to make contact with the shoes.
- Deprez - D'Arsonval Galvanometer.** See **D'ARSONVAL GALVANOMETER**.
- Déri Motor.** A form of alternating current *Repulsion Motor* employing two sets of brushes per pole in which the speed is regulated by varying the angle embraced by each pair. Used in textile machinery drive and other work where smooth speed regulation over a large range is required.
- Déri Winding.** A form of *Compensating Winding* to improve the commutation of high speed continuous current turbo-generators.
- Derived Circuit.** An old-fashioned term for a part of a circuit in parallel with another part; more usually called a *Shunt Circuit*.
- Derived Units.** Units which are functions of one or more of the fundamental units. Thus although the units of time and distance are fundamental, that of speed is derived.
- Derrick.** The structure on the roof of a telephone exchange to which overhead wires are brought.
- De Sauty's Method.** A method of comparing capacitances in which they are balanced in two arms of a Wheatstone bridge. The other two arms contain resistances which are adjusted till no kick is produced in the galvanometer when the battery key is closed.
- Desk Switchboard.** A switchboard, usually for remote control, in which part or all of the operating switch

handles, instruments, pilot-lamps, etc., are mounted on panels slightly inclined from the horizontal, like the surface of a desk.

Despatcher, Load. See **LOAD DESPATCHER**.

Dessauer Connection (of Transformers). A method of connecting high tension transformers for testing "X" Ray and other work in which the centre of the H.T. secondary is connected to the centre of the primary to reduce the potential between them. The primary is supplied through an auxiliary one-to-one transformer.

Dessicator. An apparatus used to draw artificially dried air through the interstices of a *Air Space* or similar telephone cable to keep up its insulation resistance.

Destination Indicator. See **TRAIN DESCRIPTOR**.

Destructor Station. A *Generating Station* in which the whole or part of the power driving the generators is obtained from the combustion of refuse.

Detachable Key Switch. A branch switch only workable by a handle which can be removed.

Detachable Teeth. Armature teeth fixed by dovetails or some other arrangement which allows of their removal for inspection of the winding, or so that former-wound coils can be used with partially closed slots.

Detector. (1) A rough form of *Galvanometer* for detecting the presence of a current in a circuit as a test for its continuity. (2) An appliance for detecting electric waves in wireless telegraphy, etc., by converting them into a form capable of affecting a telephone, galvanometer, or other instrument.

Detector: Armstrong-Orling, Capillary, Crystal, Earth, Electrolytic, Gas, Harmonic, Heterodyne, Hozier-Brown, Ionised-Gas, Leakage, Linesman's, Lodge-Muirhead, Magnetic, Neon, Perikon, Permanent Crystal, Pyron, "Q and I," Rectifying, Rutherford, Silicon, Tantulum, Thermal, Thermionic and Valve. See **ARMSTRONG-ORLING DETECTOR, CAPILLARY DETECTOR, etc.**

Detector Circuit. The part of the

circuit in a wireless receiving station which contains the detector.

Detector Tube or Detector Valve. A *Thermionic Valve* used as a detector of wireless signals. See also **ANODE BEND RECTIFICATION, COMMUTATIVE GRID RECTIFICATION, and TWO-ELECTRODE RECTIFICATION.**

Detonator: High Tension and Low Tension. See **HIGH TENSION DETONATOR and LOW TENSION DETONATOR.**

Detuning (Distuning or Mistuning). The alteration of the period of oscillation of a circuit from that of the waves being dealt with. In certain circumstances, particularly with *Quenched Spark* working, a slight detuning in the direction of higher frequency is of advantage.

Deviation. The angle which the direction assumed by the magnetic needle in a ship's compass makes with the true direction of North and South, due not only to the lack of coincidence of the magnetic and geographical meridians, but also to the presence of magnetic material on board the ship. Cf. **DECLINATION.**

Deviation: Semicircular and Quadrantal. See **SEMICIRCULAR DEVIATION and QUADRANTAL DEVIATION.**

Diacathode Rays. See **POSITIVE RAYS.**

Diacritical Point. The point on a curve connecting intensity of magnetisation (*J*) and *Magnetising Force* (*H*) where the former has half its saturation value.

Diagram of Reception. A polar diagram in which the length of the vector in any direction is proportional to the sensitiveness of a wireless receiving station, i.e. strength of received signal, in that direction. Such diagrams are sometimes described as *Heart-Shaped, Cardioid, or Apple-Shaped.*

Dial (Automatic Telephony). (1) Noun; see **CALLING DIAL.** (2) Verb; see **DIALLING.**

Dial: Calling, Cyclometer, Illuminated, and Meter. See **CALLING DIAL, CYCLOMETER DIAL, etc.**

Dial Pattern Bridge. A form of Wheatstone's Bridge, in which the

coils are connected to rings of contact blocks arranged so that resistances are put into circuit by inserting plugs instead of by withdrawing them as in the more usual type of bridge.

Dial Telegraph System. See A.B.C. TELEGRAPH SYSTEM (WHEATSTONE).

Dial Switch. A multiple contact switch with a circular ring and fixed contacts over which move one or more radial contact arms.

Dialling. Making a call by the operation of a *Calling Dial* in automatic telephone systems.

Dialling, Battery, Duplex, Loop, and Simplex. See BATTERY DIALLING and DUPLEX DIALLING.

Dialling Tone. A signal heard in the receiver of an automatic telephone shortly after it is lifted preparatory to making a call, consisting of a "purring" sound indicating that the subscriber's line switch has made connection with further selecting apparatus and that all is ready for *Dialling* to commence.

Diamagnetic. A substance is said to be "Diamagnetic" when its permeability is less than that of a vacuum. Such bodies are repelled by a magnetic pole and tend to set themselves across instead of along the lines of force. Cf. PARAMAGNETIC and FERRO-MAGNETIC.

Diamagnetism. The reversed magnetic properties shown by *Diamagnetic* substances.

Diameter, Pitch. See PITCH DIAMETER.

Diameter of Commutation. The diametral plane in which the actual coils in an armature winding undergoing commutation, and of the brushes, if they are not displaced angularly therefrom, must be situated for commutation to be perfect. See AXIS OF COMMUTATION.

Diametral Winding. An armature winding in which the number of slots is an exact multiple of the number of poles.

Diametrical Voltage. The voltage between opposite lines in a six-phase system, i.e. a diameter of the hexagon by which the system may be represented.

Diamond Type Coil. A former wound

armature coil forming a figure with six straight sides and with definite kinks at the ends, as for a barrel winding. Cf. SHORT TYPE COIL.

Diaphragm. (1) A thin flexible plate, such as that in a telephone transmitter or receiver, capable of vibrating in accordance with sound waves. (2) A porous separator in a primary or electrolytic cell, preventing mixture of the anolyte and the catholyte, but allowing the free passage of ions. (3) A porous sheet used as a *Separator* in an accumulator cell.

Diaphragm Currents. Currents set up by the forcing of a liquid through a porous diaphragm. Cf. OSMOSIS (Electric).

Diaphragmless Microphone. A telephone transmitter without a mechanical vibrating system, e.g. where the sound waves act upon a flame, arc, glow discharge, or ionised space between a Nernst glower and a cold electrode.

Diathermic Coagulation. The use of high frequency currents to effect albumen coagulation when passed through the body.

Diathermic Surgery. Operative surgery employing a high frequency current as a cutting agent.

Diathermy. A curative application of electricity in which fairly large currents at a frequency corresponding to a wave length of about 300 metres which is too high for them to be felt are passed through the tissues to give a warming effect.

Diatriene. An insulating compound used for the impregnation of paper for the dielectric in cables.

Dictaphone Reception. A method of reception of high speed wireless signals in which the diaphragm of the receiving telephone actuates the stylus of a "dictaphone" or phonograph, obtaining a permanent record on a wax cylinder which can afterwards be run slower for reproduction.

Dielectric. A substance containing few, if any, free electrons, which therefore resists the passage of an electric current, and can stand the application of considerable potential difference without giving way

to the electrostatic stress and allowing a discharge to pass. A dielectric can therefore be used as an insulating material for cables, etc., or for the medium separating the electrodes of a condenser. The term was originally introduced by Faraday for a non-conducting substance through which induction can take place. The term *Insulant* is preferred by some modern writers.

Dielectric: Perfect, Pseudo, and True. See PERFECT DIELECTRIC, PSEUDO-DIELECTRIC, etc.

Dielectric Absorption. The apparent property of the dielectric in a condenser of absorbing part of the charge which is only given out gradually after the main discharge. This effect is probably due to inequalities in the successive layers of the dielectric, which result in the potential gradient due to the capacitances of the series of condensers to which it is equivalent from that due to their resistances, so that compensating currents have to flow before equilibrium is established.

Dielectric Co-efficient or Dielectric Constant. See PERMITTIVITY.

Dielectric Fatigue. The property of some dielectrics of losing their power of resistance to disruption after a difference of potential has been applied for a considerable time.

Dielectric Hysteresis. The lagging of the field produced by an alternating e.m.f. in a dielectric, producing a dissipation of energy analogous to *Magnetic Hysteresis*.

Dielectric Hysteresis Loss. The energy used up and converted into heat when a dielectric is subjected to an alternating voltage; analogous to *Magnetic Hysteresis Loss* in iron, etc.

Dielectric Polarisation. A term sometimes used to indicate the extent of the electrical stress in a dielectric. See also DISPLACEMENT.

Dielectric Resistance. See INSULATION RESISTANCE.

Dielectric Rigidity. See DIELECTRIC STRENGTH.

Dielectric Separator. An apparatus for separating minerals from other

material occurring with them, depending for its action upon differences in *Dielectric* constant. The crushed ore, suspended in a liquid of dielectric constant intermediate between those of the materials to be separated, is caused to pass between electrodes connected to an a.c. circuit of moderate voltage, whereupon the mineral of higher dielectric constant adheres to the electrodes while the rest passes on. Cf. ELECTROSTATIC SEPARATOR.

Dielectric Strain. The effect of *Dielectric Stress* caused by the application of potential difference to a dielectric which, if increased beyond a certain amount, causes breakdown of the material and a disruptive discharge to pass.

Dielectric Strength. The capacity of a dielectric to prevent an electric discharge taking place through it; measured by the voltage gradient required to cause breakdown (usually in kilovolts per millimetre), which however for the same material varies according to circumstances. (Also called *Disruptive Strength*, *Electric Strength*, *Puncture Strength*, and *Dielectric Rigidity*.)

Dielectric Stress. The tendency of an electric force to produce disruptive breakdown of a dielectric, i.e. the cause of *Dielectric Strain*.

Dielectric Viscosity. The property, much more marked in some dielectrics than in others, which causes the rise and fall of charge in a condenser to lag behind the changes of potential producing it.

Diesel-Electric Locomotive. A self-contained locomotive driven by a Diesel engine through electric transmission gear. Cf. PETROL-ELECTRIC TRACTION.

Difference of Potential. See POTENTIAL DIFFERENCE.

Differential Arc Lamp. An *Arc Lamp* depending for its regulating action on the balance between the magnetic forces due respectively to a series winding tending to separate the carbons, and a shunt winding tending to bring them together.

Differential Booster. A *Reversible*

Booster for battery regulation in which a series field coil tends to lower the booster voltage when the demand for current is great so as to allow the battery to discharge, and a shunt coil tends to keep up the booster voltage in order to charge the battery.

Differential Compound Winding. A Compound Winding in which the series winding is in opposition to the shunt winding. Cf. CUMULATIVE COMPOUND WINDING.

Differential Compounding. The addition to a machine of a *Differential Compound Winding*.

Differential Duplex (Telegraph) System. A Duplex system in which each receiving instrument has two coils connected so that the currents are in opposition in the instrument at the sending station, and are in the same direction at the receiving station, thus only affecting the latter. Cf. *BIDDER DUPLEX*.

Differential Electromagnet, Excitation and Galvanometer. See DIFFERENTIAL WINDING.

Differential Fading. Unequal fading of waves of different *Side Bands* resulting in extreme cases in unintelligible signals occurring, particularly in shortwave transmission.

Differential Iron Tester. An instrument for testing iron and steel used for magnetic quality, consisting of two *Magnetic Squares* similar to those used in the Epstein apparatus, containing test and comparison specimens respectively, and connected to a differential wattmeter that no deflection is produced when the magnetic quality of the two specimens is the same. In the test the deflection is brought to zero by adjustment of direct adding resistances.

Differential Leakage (in Induction motors, etc.). *Magnetic Leakage* through the air gap, due to such causes as given under *Belt Leakage* and *zig-Zag Leakage*, which introduce higher harmonics into the field, also called *Tooth Top, Double, unequal and Higher Harmonic leakage*.

Differential Microphone. A form of microphone in which extra sensitivity is obtained and the effect of

non-linear relation between pressure and resistance of carbon is avoided by utilising two carbon elements, one subjected to increase of pressure on one side of the diaphragm and the second to decrease of pressure on the other side. (Also called *Push-Pull Microphone* and *Double Button Microphone*.)

Differential Permeability. The ratio of a small change of magnetic *Flux Density* (B) to the change of *Magnetising Force* (H) producing it, i.e. the slope of the magnetisation curve at the point in question (or dB/dH).

Differential Relay. See DIFFERENTIAL WINDING.

Differential Resistance. An expression used in cases where *Ohm's Law* does not apply for the ratio of a small change in e.m.f. to the corresponding change in current (dE/dI).

Differential Susceptibility. The ratio of a small change of *Intensity of Magnetisation* (J) to the change of *Magnetising Force* (H) producing it (i.e. dJ/dH).

Differential Winding. Any winding in machines, instruments, relays, arc-lamps, etc., in which two sections are connected in opposition and the flux produced depends upon the difference in the ampere-turns in the two sections of the winding.

Differentially-Wound Motor. A direct current motor, provided with a series winding in opposition to the shunt winding, to weaken the field as the load rises, in order to maintain constant speed. Cf. COMPOUND-WOUND MOTOR.

Diffraction Electron. See ELECTRON DIFFRACTION.

Diffuse Reflection Factor. See REFLECTION FACTOR.

Diffused Lighting. Lighting in which the whole of the light reaches the area to be illuminated through a diffusing medium, or by diffused reflection.

Diffused Reflection: Coefficient of. See REFLECTION FACTOR.

Digit Finder. A selector (in automatic telephony) for making connection between a *Code Selector* and a disengaged *Digit Selector*.

Digit Selector. A selector (in automatic telephony) acting as intermediary between a *Code Selector* and a *Director*.

Dimmer. A variable solid or liquid resistance, which can be gradually inserted into an electric light circuit to reduce the intensity of the light; used particularly in stage lighting, etc.

Dimmer, Liquid and Reactance. See **LIQUID RESISTANCE AND REACTANCE DIMMER**.

Dimmer Wheel. A handwheel operating a single *Dimmer* or a number of dimmers coupled together.

Dimming Resistance and Dimming Switch. See **DIMMER**.

Diode. A *Thermionic Valve* with two electrodes, the filament and the plate, and consequently three terminals, e.g. the original *Fleming Oscillation Valve*. Cf. **TRIODE**.

Diode Multiplex. See **MORSE MULTIPLEX SYSTEM**.

Diode-Triode, Double. See **DOUBLE DIODE-TRIODE**.

Dionic Water Tester. A form of *Electrolytic Water Tester* for measuring the hardness of feed water, etc.

Dip. (1) The angle between the direction of the earth's magnetic force at any part of the earth's surface and the horizontal plane; in London, about 67° . (Also called **INCLINATION**). (2) The sag of an overhead wire in telegraphy, etc. (3) A plug for making temporary stage lighting connections.

Dip Circle. An instrument by which the angle of *Inclination* or *Dip* can be measured accurately by means of a magnetic needle pivoted on a horizontal axis. Cf. **DIPPING NEEDLE**.

Dip Needle, Miner's. See **MINER'S DIP NEEDLE**.

Diphase. An expression sometimes used for *Two-Phase*.

Diplex (Telegraph) System. A system in which two messages can be sent at the same time in the same direction over the same line. In wireless the term is applied to a system in which different messages are sent out simultaneously from the same station on different wave lengths. Cf. **DUPLEX**.

Diplex Wireless Reception. Reception

of two messages simultaneously on the same aerial or at the same carrier frequency.

Dipolar. Two-pole.

Dipole. A pair of (positive and negative) poles present in a molecule due to absence of some of the normal number of electrons, having the effect of groups of molecules taking up a different orientation in an electric field and possibly explaining certain features of dielectrics.

Dipole Oscillator. An oscillator such as the Hertz form with extended antennae on both poles. See also **HARTLY CIRCUIT**.

Dipper Relay. A submarine cable relay of the moving coil type, in which one or other of two fine platinum wires dip into an acid bath to establish a circuit.

Dipping Needle. A magnetic needle pivoted on a horizontal axis for determining roughly the angle of *Dip*, called by the older writers *Inclinatorium*. Cf. **DIP CIRCLE**.

Direct Arc Furnace. An arc furnace in which the arc is formed between the actual charge and an electrode, e.g. the *HÉROULT FURNACE*. See also **SERIES ARC FURNACE** and cf. **INDIRECT ARC FURNACE**.

Direct Circuit. A telegraph circuit not worked through a *Relay*.

Direct Coupled Exciter. An *Exciter* driven by the same shaft as the machine which it excites.

Direct Coupled Generator. A generator mechanically connected to the shaft of the engine, turbine, or motor driving it, i.e. not driven through gearing of any kind.

Direct Current (D.C.) (1) A current which does not change its direction, as opposed to an *Alternating Current*, also called *Continuous Current*, usually limited to currents sensibly free from pulsation. (2) The current impulse induced in a coil by the withdrawal of a magnet; so called because it is in the same direction as that required to magnetise the magnet with its existing polarity, as opposed to an *Inverse Current* induced by inserting the magnet.

Direct Current Balancer. A motor-generator consisting, in its simplest form, of two shunt-wound machines coupled together with the armature of each connected across one side of a three-wire system and the field across the other, so that the machine on the more lightly loaded side acts as a motor and causes the other to deliver current to the more heavily loaded side, and thus to help to maintain the balance. Another form of balancer in early three-wire stations consisted of two generators with hand voltage control driven by one engine and was known as a *Steam Balancer*.

Direct Current Generator. A generator giving only direct current. (The term *Dynamo* is commonly limited to this meaning.)

Direct Current Locomotive. An electric locomotive driven by direct current motors.

Direct Current Meter. A supply meter for use on direct current circuits only, e.g. *Mercury Meter*, *Electrolytic Meter*, etc.

Direct Current Motor. An electric motor worked by direct current.

Direct Current Resistance. A term often preferred to *Ohmic* or *True Resistance* for the resistance offered by a circuit, etc., to direct current. Cf. *HIGH FREQUENCY RESISTANCE*.

Direct Current Traction. *Electric Traction* employing direct current motors, often combined with alternating current transmission to the substations which feed the contact line or rails. Cf. *SINGLE PHASE* and *THREE-PHASE TRACTION*.

Direct Current Transformer. A term sometimes used for a motor-generator or a single armature converter for converting direct current from one voltage to another.

Direct Drive (in Wireless Transmission). Arrangements in a transmitting system whereby the frequency of the main oscillations is determined entirely by the constants of the main oscillating circuit itself. Cf. *INDEPENDENT DRIVE*.

Direct Illumination or Lighting.

Lighting where the greater part of the light reaches the object direct from the lamps without diffused reflection. Cf. *INDIRECT* and *SEMI-INDIRECT LIGHTING*.

Direct (Telephone) Line. A telephone line from an exchange to a single subscriber, as opposed to a *Party Line* serving several subscribers, called in the U.S.A. an "individual line."

Direct Rays (in Wireless Transmission). The part of the radiation, approximately parallel to the ground, which reaches the receiving apparatus without downward reflection or refraction from the *Ionosphere*. See *INDIRECT RAYS*.

Direct Reading Direction Finder. A *Wireless Direction Finder* in which a rotating receiving loop is coupled to the magnet of a moving coil instrument through the coil of which the amplified received signal is sent, so that it tends to set itself in the direction of the maximum signal strength.

Direct Reading Instruments. Instruments in which the reading indicates the magnitude of the quantity to be measured in ordinary units, without multiplication by a constant.

Direct Trip. A tripping device operated by the current in the circuit itself. Cf. *INDEPENDENT TRIP*.

Direction Finder. See *WIRELESS DIRECTION FINDER*.

Direction Finder: Adcock, Cathode Ray, Direct Reading, Robinson's and Wireless. See *ADCOCK DIRECTION FINDER*, *CATHODE RAY DIRECTION FINDER*, etc.

Direction Switch (in Electric Lifts). A switch determining the direction of motion of a lift motor.

Directional Aerial. An aerial arranged to send out waves of maximum amplitude in a particular direction and also in the directly opposite direction but nearly zero amplitude in directions at right angles to this. Cf. *UNIDIRECTIONAL AERIAL*.

Directional Circuit-Breaker. A circuit-breaker arranged to operate when a current in a reverse direction or contrary phase from the

normal passes, or when power is flowing in the reverse direction from the normal, e.g. from the line to the generator. Cf. DISCRIMINATING CIRCUIT-BREAKER.

Directional Collective Automatic Lift Control. A system of automatic lift control in which calls not requiring reversal of direction of the travel of the car are answered before those entailing travel in the opposite direction.

Directional Receiver. A wireless receiver having maximum sensitivity to signals coming in from a particular direction and also from a directly opposite direction and minimum sensitivity as regards directions at right angles to this.

Directional Relay. See DISCRIMINATING RELAY.

Directional Wireless Telegraphy. Wireless telegraphy in which the waves are confined as nearly as possible to the direction between the transmitting and receiving stations. See also BEAM SYSTEM OF WIRELESS TELEGRAPHY.

Directive Aerial. An aerial arranged to send out waves of maximum amplitude in a particular direction and usually also in the directly opposite direction but nearly zero in directions at right angles to this. Cf. UNIDIRECTIONAL AERIAL.

Directive Efficiency (of a Directional Aerial). A measure of the field strength given in one particular direction compared with that in all directions.

Directive Force. The couple due to the earth's field, which causes a pivoted magnetised needle to turn into a north and south direction; or, more generally, the property of magnetic bodies of orientation. (Also called by Gilbert and the early writers, *Versorial Force* or *Veracity*.)

Directive Radio-Beacon. A Radio-Beacon with a *Directive Aerial*. Cf. OMNI-RADIO BEACON and COURSE INDICATING RADIO-BEACON.

Directive Transmitter. A wireless transmitter employing a *Directive Aerial*.

Directivity (of a Directional Aerial). A term sometimes used both for

Directive Efficiency and *Sharpness of Directivity*.

Directly Heated Cathode. A cathode of a *Discharge Tube* directly heated by current passing through it. Cf. INDIRECTLY HEATED CATHODE.

Director. An apparatus used in certain step-by-step automatic telephone systems, which, after being connected to the subscriber's line by a *Line Switch* or *Preselector*, not only receives and stores up the signal impulses forming the call until further vacant selecting apparatus is available, but translates the call in a way which secures transmission over the most suitable route by selecting a suitable vacant *Junction Selector*. (Also called a *Register Translator*.)

Director Automatic Telephone System. The automatic telephone system adopted by the British Post Office based on the Strowger step-by-step system with the addition of the *Director* and other special features.

Dis. A colloquial term for an accidental discontinuity or disconnection in a circuit.

Disabled Motor Switch. A switch for rearranging the connection in a traction controller so that one motor is entirely cut out of circuit.

Disappearing Filament Pyrometer. See OPTICAL PYROMETER.

Disc, Arago's. See ARAGO'S ROTATIONS.

Disc, Armature. See ARMATURE CORE DISC.

Disc, Faraday's. See FARADAY'S DISC.

Disc (Type) Alternator. A type of alternator, such as the old Siemens and Ferranti machines, in which the armature consisted of a revolving disc carrying flat ironless coils passing between two sets of field poles.

Disc (Type) Armature. An early form of flat armature with no revolving iron and one layer of radial active wires moving in an axial field. Cf. DISCOIDAL ARMATURE, which is often referred to simply as a "disc" armature.

Disc Brake. A type of tramcar or other brake, in which the torque is due to the reaction of currents

induced in a disc by an electromagnet, excited from the motors acting as generators or otherwise.

Disc Commutator. See RADIAL COMMUTATOR.

Disc Discharger (Marconi). See ROTARY SPARK- GAP.

Disc (Transformer) Winding. A winding used chiefly for high voltages consisting of an assemblage of flat spiral coils side by side, sometimes alternately reversed in direction to simplify connection. Cf. CYLINDRICAL WINDING.

Discharge. (1) A more or less sudden passage of electricity. A term most often used of passage of electricity through gases, and especially one which restores electrical equilibrium and reduces conductors to their normal uncharged state, e.g. the discharge of a *Leyden Jar*. (2) The return of the stored energy in a secondary battery in the form of a current. (3) Also used as a verb, to effect a discharge.

Discharge: Brush, Conductive, Convective, Corona, Dark, Disruptive, Electron, Electronic, Geissler, Globular, Glow, Oscillatory, Spark, and Silent. See BRUSH DISCHARGE, CONDUCTIVE DISCHARGE, etc.

Discharge Current, Anomalous and Normal. See ANOMALOUS DISCHARGE CURRENT and NORMAL DISCHARGE CURRENT.

Discharge Electrode (in Electrical Precipitation). See ACTIVE ELECTRODE.

Discharge Lamp. A tubular or other lamp in which the light is produced by luminescence of a gas or vapour at a low pressure through which a discharge is passed between suitable electrodes; sometimes with the assistance of fluorescent materials on the inner surface of the tube. See NEON LAMP, HOT CATHODE DISCHARGE LAMP, SODIUM LAMP, MERCURY VAPOUR LAMP, etc.

Discharge Rate. An accumulator battery is said to have a certain capacity at the "one hour discharge rate" when that is the whole number of ampere-hours that it can give if uniformly and completely discharged in that time. If discharged at a slower

"discharge rate" the capacity is higher.

Discharge Rays. A name sometimes given to active ultra-violet radiation from the *Negative Glow*, which causes fluorescence of the glass at gas pressures between about 1/2000 of an atmosphere. Cf. CATHODE RAYS.

Discharge Resistance. A non-inductive resistance placed in parallel with a piece of apparatus of high inductance to prevent dangerous rise of potential on switching off.

Discharge Tube. A closed glass or other vessel containing gas at a very low pressure and fitted with electrodes or otherwise arranged for an electric discharge to pass through the gas when a sufficiently high voltage is applied, for the production and investigation of phenomena occurring only at low gas pressures. See GAS DISCHARGE TUBE, VACUUM TUBE, CATHODE RAY TUBE, THERMIONIC VALVE, "X" RAY TUBE, DISCHARGE LAMP, etc.

Discharge Tube Rectifier. A rectifier of the *Discharge Tube* type, e.g. a LODGE VALVE.

Discharger. (1) A spark gap or other arrangement which provides a path for an electrical discharge. (2) The apparatus containing the electrically heated wire for firing explosive charges in electric blasting.

Discharger: Aerial, Disc, Lepel, Multigap, and Rotary. See AERIAL DISCHARGER, DISC DISCHARGER, etc.

Discharging Current. (1) The proper rate at which a particular accumulator should be discharged. (2) The current given by an accumulator during its discharge. (3) The current obtained by the discharge of a condenser. See references under DISCHARGE CURRENT.

Discharging Tongs. A pair of hinged metal rods terminating in knobs and provided with insulating handles for discharging Leyden jars.

Discoidal Armature. An early form of armature of the flat ring variety in which radial active wires on both sides, move in a radial field, e.g. some old designs of Brush machines. Cf. DISC ARMATURE.

Disconnecting Lamp. See **CLEARING LAMP.**

Disconnecting Links or Switches. See **ISOLATORS.**

Discontinuity. A break in the conductivity of an electric circuit. See also **MAGNETIC DISCONTINUITY.**

Discontinuous Integration. See **INTERMITTENT INTEGRATION.**

Discontinuous Rating. See **INTERMITTENT RATING.**

Discontinuous Running. See **INTERMITTENT RUNNING.**

Discontinuously Integrating Meter. See **INTERMITTENT INTEGRATION.**

Discriminating Circuit-Breakers, Cut-Outs, and Relays. A term originally used for *Directional Circuit-Breakers*, etc., but now more commonly limited to apparatus designed to isolate only the faulty section of the network.

Discriminating Protective System. An expression formerly used for a *Protective System* employing reverse power relays, but now generally for any system in which the circuit breakers only open on the occurrence of a fault on the particular part of the system which they are intended to protect.

Discriminating Selector (in Automatic Telephony). A selector which discriminates between local calls and those to be passed on to another exchange.

Discriminating Selector Repeater. A type of *Group Selector* used in some satellite automatic exchanges which either selects further selectors in its own exchange for local calls or passes them on to the main exchange according to the code letter received.

Discriminator. An instrument used with an earlier system of charging of an electric supply which automatically switches over to a different meter when a predetermined maximum demand has been exceeded.

Disintegration of Filament. The projection of particles from the filament of an incandescent lamp causing blackening of the bulb.

Disintegration Product. The changed substance which remains after the loss of electrons due to *Radio-Activity*.

Dispersion. See **MAGNETIC LEAKAGE**, and references under *Leakage*.

Dispensable Circuit. A separate circuit in house wiring, used in a particular tariff system, to which are connected such appliances as can be used only at times of light load, when the supply is charged for at a lower rate.

Dispersion Coefficient. See **CIRCLE COEFFICIENT** and **LEAKAGE FACTOR.**

Dispersion Photometer. A photometer in which the light from strong sources is reduced in intensity by a known amount by the use of lenses before being compared with the standard.

Displacement (Electric). A term, proposed originally by Maxwell for a quantity expressing the state of a dielectric in an electric field according to the conception that the field is produced by transferring positive electricity to one end and negative electricity to the other; being the amount of electricity so transferred along each tube of force. The same quantity looked at from different points of view has also been called *Electrostatic Induction*, *Electrostatic Flux-Density*, *Dielectric Polarisation* and *Electric or Dielectric Stress*. Symbol: *D*.

Displacement Boxes. Lead boxes used in telephone exchange and other accumulator cells to occupy space in the tank provided for the addition of further plates for extensions so as to minimise the amount of electrolyte necessary.

Displacement Current. The effect similar to that of a current of an alteration of electrical stress in a dielectric, e.g. the capacitance "current" which flows into the dielectric which surrounds a conductor while the main current is increasing and from the dielectric when the main current is decreasing.

Display Panel (in Telephony). The actual illuminated signal panel on a *Call Indicator* position.

Disruptive Discharge. A sudden passage of electricity, usually accompanied by evolution of heat, light, and sound, such as a *Spark* or lightning flash, caused by the

- breakdown of the insulating property of a medium after the application of a higher voltage than it is able to stand. In the case of solids a puncture is produced, which is not self-healing as in liquids and gases, but leaves permanent damage.
- Disruptive Spark.** A spark purely of the nature of a *Disruptive Discharge* and not becoming an Arc. Cf. BREAK SPARK.
- Disruptive Strength.** See DIELECTRIC STRENGTH.
- Disruptive Voltage.** The voltage required to produce a *Disruptive Discharge* through a particular piece of insulating material. See BREAKDOWN VOLTAGE.
- Dissipation of Charge.** Gradual loss of the charge in a conductor due to leakage through the surrounding dielectric.
- Dissipator, Surge.** See SURGE DISSIPATOR.
- Dissociation, Electrolytic.** See ELECTROLYTIC DISSOCIATION.
- Dissociation Theory.** The theory whereby electrolytic conduction is explained by assuming that substances in solution are dissociated into positive and negative ions which travel in opposite directions carrying their respective charges.
- Distance : Sparking and Striking.** See SPARKING DISTANCE AND STRIKING DISTANCE.
- Distance Control.** See REMOTE CONTROL.
- Distance Relay.** A protective relay put into action by and with its time-lag controlled by changes in the impedance or reactance of the circuit so that the time-lag practically depends on the distance away of the fault.
- Distorted Waves.** An expression sometimes used for waves which differ in wave-form from a true sine wave-form.
- Distortion.** Impairment in the quality of line or wireless telephone reproduction due to alteration in wave form; produced in long distance telephone lines of considerable inductance and capacitance, owing to the unequal velocities of propagation of the components of different frequency, and due to a variety of causes in wireless telephony. See below. Cf. ATTENUATION.
- Distortion : Amplitude, Frequency, Linear, Non-Linear, Phase, and Tone.** See AMPLITUDE DISTORTION, FREQUENCY DISTORTION, etc.
- Distortion of Field.** The alteration in the direction and distribution of the field of a machine due to *Armature Reaction*.
- Distortive Power.** See HARMONIC POWER.
- Distributed Capacitance.** See SELF-CAPACITANCE.
- Distributed Inductance.** See CONTINUOUS LOADING.
- Distributed Winding.** A winding spread uniformly over the whole stator or rotor surface.
- Distributing Board.** See DISTRIBUTION BOARD.
- Distributing Box.** See DISTRIBUTION BOX.
- Distributing Centre.** A point in a distributing network of mains to which the main supply is taken by a feeder.
- Distributing Frame.** See DISTRIBUTION FRAME.
- Distributing Mains.** Mains running throughout the district to be served from which the supply is given through service cables to consumers.
- Distributing Network.** A complete system of *Distributing Mains*.
- Distributing Pillar.** See DISTRIBUTION PILLAR.
- Distributing Point.** A junction between a feeder and one or more distributing mains.
- Distributing System.** The whole system of mains, etc., by which a supply is given to the consumers in an area of supply.
- Distribution Board.** A board from which connections are taken off to a number of branch circuits from a set of mains or sub-mains, usually provided with a fuse for each pole of each branch circuit, and sometimes switches of links.
- Distribution Board System of Wiring.** The usual system of interior wiring in which all branches are taken from *Distribution Boards* in the *Mains* or *Submains*. Cf. TARE SYSTEM.

Distribution Box. An enclosed *Distribution Board*.

Distribution Factor. A factor used in alternator design to allow for the different phase of the e.m.f. induced in different conductors of a distributed winding.

Distribution Frame. The iron frame in a telephone exchange, or large telegraph office, to which all incoming and outgoing circuits are brought so that testing and other connections may be made, and carrying such apparatus as *Heat Coils*, *Fuses*, etc. See **MAIN**, **INTERMEDIATE**, and **COMBINED DISTRIBUTING FRAMES**.

Distribution Frame, Intermediate and Main. See **INTERMEDIATE DISTRIBUTION FRAME** and **MAIN DISTRIBUTION FRAME**.

Distribution Fuse Board. A distribution board with fuses on each branch circuit, usually on both poles.

Distribution Pillar. A distributing box in the form of a pillar, usually of cast iron for interconnection between distributing mains.

Distribution Switch Board. A *Distribution Board* with switches on each branch circuit.

Distributor. (1) A cable forming part of a *Distributing Network* or *System*. (2) A box where provision is made for connecting a number of cables to a single cable. (3) The revolving contact maker arrangement in *Multiplex* telegraph systems which gives the exclusive use of the line to the various different instruments or parts of the same instrument, in turn. (4) The apparatus, in high tension electric ignition which puts the high tension circuit in communication with the sparking plugs on the different cylinders in the proper sequence.

Distributor, Parallel and Traffic. See **PARALLEL DISTRIBUTOR** and **TRAFFIC DISTRIBUTOR**.

Detuning. See **DETUNING**.

Disturbing Voltage, Equivalent. See **EQUIVALENT DISTURBING VOLTAGE**.

Diurnal Variation. The very small variation (less than 10 min.) in the direction of the magnetic meridian which occurs daily. Cf. **ANNUAL** and **SECULAR VARIATION**.

Diversity (Wireless) Receiving System. A method of controlling reception from two or more widely spaced aeriols to minimise effects of *Fading*.

Diverter. A resistor, sometimes adjustable, placed in parallel with a portion of a circuit to regulate the proportion of the total current that flows through it, particularly in the case of series windings of compound wound machines or the windings of commutating poles.

Diverter Relay. A Relay employed in some protective systems to increase the stability of the main tripping relay by cutting in a resistance in case of a heavy fault.

Diverter Type Field Rheostat. A *Field Rheostat* connected in parallel with the field winding.

Divided Magnetic Circuit. A magnetic circuit in part of which the flux divides into two separate paths.

Divided Touch. A method of magnetising a bar of steel by stroking it simultaneously with two permanent magnets, presenting opposite poles, which are drawn apart from the centre to the ends of the bar. Cf. **DOUBLE TOUCH** and **SINGLE TOUCH**.

Divided Winding. A term proposed, in view of the confusion between the terms multiple and multiplex, for a winding consisting of several independent sections joined in parallel by the brushes. Cf. **CONTINUOUS WINDING**.

Divider, Frequency and Potential. See **FREQUENCY DIVIDER** and **POTENTIAL DIVIDER**.

Dividing Box. A cast-iron or other box for connecting a multicore or concentric cable to single core cables for each phase or circuit.

D.K. Tests of Cables. Tests of dielectric capacitance. Cf. **D.R.** and **C.R.**

"D" Layer. An ionised layer in the atmosphere, lower than the *Kennelly-Heaviside* or "E" Layer and the *Appleton* or "F" Layer at a height of 40 to 50 km. which can reflect fairly long waves, especially in the early morning.

Dog-fish, Electric. A fish (*Astroscopus y-gracum*) found on the Atlantic

coast of the U.S.A. said to have electric properties.

Dolezalek Electrometer. A specially sensitive form of *Quadrant Electrometer*.

Dolly. The operating handle of a *Tumbler Switch*.

Domestic Electrical Apparatus. See RADIATOR, COOKER, OVEN, KETTLE, WATER-HEATER, SAUCEPAN, FRYING-PAN, BOILING-PLATE, HOT-PLATE, BOILER, IRON, CARPET, BLANKET, HOT-PAD, HAIR-DRYER, VACUUM-CLEANER, FLOOR POLISHER and WASHING MACHINE.

Door Contact. A device which closes a circuit on a door being opened in order to ring a bell, or to give some other alarm signal, or to switch on a light.

Door Switch. A switch arranged to be worked by the opening and closing of a door.

Dose Meter. An instrument for gauging the intensity of "X" Rays, in order to determine the length of exposure required for particular cases of "X" Ray treatment.

Double Amplitude. See AMPLITUDE.

Double Bar and Yoke Method. A ballistic method of magnetic testing in which two specimen bars, surrounded by coils, are clamped into yokes to form a closed magnetic circuit. A correction for eliminating the effect of the yokes can be obtained by making a second test after sliding the yokes along the bars so that there is half the former distance between them.

Double Break (D.B.) Switch, etc. A switch, etc., opening the circuit at two points simultaneously on each pole.

Double Bridge. See KELVIN BRIDGE.

Double Button Microphone. See DIFFERENTIAL MICROPHONE.

Double Carbon Arc Lamp. See TWIN CARBON ARC LAMP.

Double (or Duplex) Catenary Suspension. A form of *Catenary Suspension* in which two bearer wires are employed side by side.

Double Commutator Motor. A continuous current motor with one armature provided with two separate commutators which can

be connected in series or parallel for speed variation.

Double Current Furnace. An electric furnace in which direct current is used for electrolytic purposes and alternating current for heating as an *Induction Furnace*.

Double Current Generator. A generator which can supply both direct and alternating current.

Double Current Key. See DOUBLE CURRENT SYSTEM.

Double Current Sounder. A sounder worked by the double current system of telegraph working.

Double Current System. Telegraph working in which the release of the key sends a reverse "spacing" current instead of simply interrupting the circuit.

Double Deck Induction Motor. A *Squirrel Cage Induction Motor* in which separate rotor windings are provided for starting and running.

Double Delta Connection. Connection of a six-phase winding to form two triangles with no neutral point.

Double Diode. The equivalent of two *Diodes* in a single bulb, one for use as a speech detector and the other to supply a variable bias proportional to the signal strength for *Automatic Volume Control*.

Double Diode Pentode. A *Diode* type detector and a *Pentode* type amplifier with separate electron streams, all contained in one bulb, used for the final stage in *Super-heterodyne Receivers*.

Double Diode Triode. A *Diode* type detector and *Triode* type amplifier contained in one bulb, with separate sets of electrodes for each.

Double Fluid Cell. A primary cell in which two different solutions are employed one for each electrode separated by a porous vessel or diaphragm.

Double Fluid Theory. See TWO-FLUID THEORY.

Double Frequency Oscillations. Oscillations which contain components with two different frequencies, as when an oscillating and an aerial circuit of different periods are inductively coupled.

Double Function Valve. See **DOUBLE PURPOSE VALVE**.

Double Insulation. (1) The provision of insulation both between a line conductor and its support, sheath, etc., and also between the latter and earth. (2) Two separate layers of insulation one over the other as a conductor, each sufficient to withstand the working voltage.

Double Layer Winding. An armature winding of the usual type with parts of two different coils one above the other in each slot. Cf. **SINGLE LAYER WINDING**.

Double Linkage Leakage. See **DIFFERENTIAL LEAKAGE**.

Double Magnetic Circuit. A magnetic circuit with two return paths of magnetic material for the flux.

Double Modulator. See **BALANCED MODULATOR**.

Double Needle Telegraph System. A system intermediate between Cooke and Wheatstone's original *Five Needles*, and later *Single Needle* systems, involving simultaneous deflection at two needles and with two keys, one worked with each hand.

Double Note Amplifier. A note amplifier with two valves in *Cascade*.

Double Pentode. A valve for the *Quiescent Push-Pull Type* of low frequency amplification in wireless receiving sets, in which two separate sets of pentode electrodes are contained in one bulb.

Double Phantom Circuit. A circuit each side of which consists of the four conductors of a *Phantom Circuit* in parallel.

Double Plate Sounder. A sounder employing separate electromagnets, controlled by a relay and giving distinctive sounds when their armatures are attracted.

Double Pole (D.P.) Circuit-Breaker, Cut-Out, Fuse, Switch, etc. A circuit-breaker, etc., in which the circuit is broken at both poles simultaneously.

Double Purpose Valve. A *Thermionic Valve* with two grids which can be employed simultaneously as a detector and as an amplifier.

Double Retroaction. *Retroaction* in a wireless receiving set, applied

simultaneously at two different frequencies.

Double Reception (wireless). Simultaneous reception of two messages on the same aerial on different wave-lengths.

Double Squirrel Cage Motor. A *Squirrel Cage Motor* with two rotor circuits, one of high resistance coming into action at starting and one of low resistance but high reactance taking up the current as the speed rises and the rotor frequency falls.

Double Tariff Meter. See **TWO-RATE METER**.

Double Throw (D.T.) Switch. A switch in which the moving contacts can be made to engage with two alternative sets of fixed contacts. Cf. **TWO-WAY SWITCH**.

Double Touch. A method of magnetising a bar of steel by stroking with the opposite poles of two bar magnets kept apart by a piece of wood, etc., and moved backwards and forwards together along the bar to be magnetised. Cf. **SINGLE TOUCH**, **DIVIDED TOUCH**.

Double Transmission (Wireless). Simultaneous transmission of two messages from the same aerial using different wave-lengths.

Double Trolley System. Electric traction on tramways or railways, where a second insulated overhead line and trolley is used for the return instead of the rails and earth; used where it is particularly desirable to avoid stray earth currents, e.g. near observatories.

Double Wire System. Electric light wiring with a separate metallic return as opposed to *Single Wire System* with an earth return.

Double Zig-Zag Connection. A modification of the ordinary *Zig-Zag Connection* with portions of the third phase on each limb arranged so that a six-phase connector is produced. Also called *Fork Connection*.

Doubler. (1) An elementary form of continuous electrophorous or *Influence Machine*. (2) A *Static Frequency Changer* giving twice the primary frequency.

Doubly Fed (Series or Repulsion) Motor. A single phase commutator motor, the armature of which

receives power partly by conduction and partly by induction. Cf. **SINGLY FED MOTOR**.

Dovetail Key. A key with inclined sides holding laminations, particularly in large coils.

Dovetail Keyway. A keyway with inclined sides, particularly in segmental stampings for large cores, by which they are held in position.

Dovetail Teeth. See **DETACHABLE TEETH**.

Down Lead. The wire connecting the main portion of an aerial to the apparatus, including the *Leading-in Wire*.

Down Lead, Screened. See **SCREENED DOWN LEAD**.

D.P. Usual abbreviation for *Double Pole*.

D.R. Tests of Cables. Tests of *Dielectric Resistances*. Cf. **C.R.** and **D.K.**

Drainage Chain (in airships). A chain which is let down before landing to put to earth charges produced by air friction or atmospheric electricity.

Drainage Coils. Differentially wound induction coils employed in protective systems to avoid parasitic currents in the pilot wire circuits by offering them a path to earth, which, however, present a high impedance to the normal fault signalling currents.

Draw-in Box or Pit. A box or pit for obtaining access to pipes, ducts, or conduits for the drawing in or out of cables.

Draw-in System. The system of cable laying in which the cables are drawn into the ducts, pipes, or conduits after these are complete.

Drawn Wire Filament. An incandescent lamp "filament" composed of tungsten or other wire made by a true wire-drawing process. Cf. **SQUINTED FILAMENT**.

Draw-out Switchgear. Switchgear in which components may be isolated by being drawn away from the rest of the assembly on guides.

Draw-Tongs or Draw-Vice. Tools for laying hold of aerial wires for straining them tight during erection.

Drill (Electric). A portable electrically driven drilling machine complete with its own motor.

Drip-Proof Motor, Switchgear, etc. Machines or apparatus are said to be drip-proof when the ventilating apertures are protected against falling water.

Drive Circuit (in a Wireless Transmitter). The circuit containing the frequency-determining apparatus where *Independent Drive* is employed.

Drive: Constant Frequency, Crystal, Direct, Group, Independent, Individual, Individual Axle, Mechanical, Quill, Side Rod and Valve. See **CONSTANT FREQUENCY DRIVE**, **DIRECT DRIVE**, etc.

Driver. An expression sometimes used for a source of oscillations in wireless telegraphy, particularly in connection with testing operations.

Driver Valve (in Wireless Receiving Sets). A term sometimes used for the valve in the amplifying stage previous to the final output stage in *Class B Amplification*.

Driving Horns. The projections provided on the surface of a *Smooth Core* armature to take the torque between the conductors and the core.

Driving Point Impedance. A term sometimes used for the ratio of the impedance a.m.f. at a particular point on an a.c. system to the current at that point.

Driving Trailer. See **CONTROL TRAILER**.

Drop: Contact, Impedance, Inductive, "I.R.," Line, Ohmic, Pressure, Reactance, Reactive, Resistance, and Voltage. See **CONTACT DROP**, **IMPEDANCE DROP**, etc.

Drop of Potential, Voltage, Pressure, etc. The difference of potential between two points on a conductor along which a current is flowing, being that required to force the current through the resistance or impedance between the points; measured in volts. Cf. **ELECTROMOTIVE FORCE** and **POTENTIAL GRADIENT**.

Drop Test. See **FALL OF POTENTIAL TEST**.

Drop-Annunciator. An *Annunciator*, in which the signal is made by the dropping of a disc.

Drop-in Winding. A winding which can be "dropped" into ready lined slots through the slot opening.

The lining is turned over and secured by a key.

Droppers. The wires, rods, etc., by which the contact line is suspended from the bearer wire or wires in *Catenary Suspension*.

Drum, Phonic. See **PHONIC DRUM**.

Drum Armature. The ordinary type of armature with axial active wires rotating in a field where the lines of force are partly radial and partly tangential. Cf. **DISCORDAL** and **RING ARMATURES**.

Drum Controller and Drum Starter. A *Controller* or *Starter* in which contact fingers press against contacts mounted on a cylinder rotated by the handle.

Drum Winding. An armature winding in which the whole of the conductors lie, in slots or otherwise, on the periphery of the core. Cf. **RING WINDING**.

Drum Accumulator. An alkaline accumulator with positive plates containing hydrated nickel oxides and negative plates of zinc, capable of high discharge rates.

Dry Battery. A battery composed of *Dry Cells*.

Dry Cell. A *Primary Cell*, usually of the *Leclanché* type, in which the electrolyte is absorbed by a semi-solid mass, for the sake of portability without spilling, as in the small batteries used in *Pocket Lamps*, *Torches*, etc., and in wireless receiving sets.

Dry Core Cable. See **AIR-SPACE CABLE**.

Dry Electrolytic Condenser. A special form of *Electrolytic Condenser* containing only dry materials, used for smoothing circuits and other purposes.

Dry Pile. An early form of *Primary Battery* consisting of a pile of discs alternately of different metals separated by paper; the only electrolyte being the slight moisture therein.

Dry Plate Rectifier. See **METAL RECTIFIER**.

Dry Spark-Over Test. A *Spark-over test* of an insulator in a clean and dry condition. Cf. **WET SPARK-OVER TEST**.

Drying-out Insulation. Warming of the windings of electrical machinery and apparatus by the passage of

a current for a considerable time to expel moisture from the insulation.

Drysdale Permeameter. An instrument for estimating the permeability of iron, etc., castings, etc., by the *Ballistic Method*. A plug carrying primary and secondary coils is inserted in an annular hole drilled in the mass to be tested by a special tool.

Drysdale Potentiometer. A special form of potentiometer for use with alternating currents, in which a known current is passed through the potentiometer wire and a phase shifting transformer is used to bring this into phase with the e.m.f. to be measured. A vibration galvanometer replaces the ordinary galvanometer.

Du Bois Balance. An instrument used for measuring the permeability of iron or steel rods by balancing the magnetic attraction across an air gap in a magnetic circuit of which the sample forms a part against a sliding weight.

Dual Amplification. The use of a single *Thermionic Valve* in a wireless receiving set, to effect both high frequency and low frequency amplification simultaneously. A circuit arranged in this way is called a *Reflex Circuit*.

Dual Ignition. Ignition arrangements on an engine which can be actuated by a battery or a magneto, or both simultaneously.

Dual Lift Control. Alternative push button and car switch control in the same lift.

Duct Ventilated Motor, etc. See **PIPE VENTILATED MOTOR, etc.**

Ducter. An instrument on the same principle as the *Megger* and *Bridge-Megger* for measuring very low resistances by a direct reading pointer.

Ducts: Air, Armature, Axial, Cable, Earthenware, Radial, and Ventilating. See **AIR DUCTS, ARMATURE DUCTS, etc.**

Duddell Arc or Singing Arc. An arc connected to an oscillating circuit which can maintain, owing to its instability, oscillations corresponding to the free period of the circuit and where the frequency is within the limits of audition, gives forth a musical note.

Duddell Oscillograph. An oscillograph in the form of a reflecting galvanometer in which two current carrying strips, in the powerful field of an electromagnet, deflect a mirror. The moving parts have a very small free period of vibration and are effectively damped by immersion in an oil bath.

Duddell Thermo-Ammeter and Thermo-Galvanometer. See THERMO-AMMETER and THERMO-GALVANOMETER.

Dull Emitter Valve. A *Thermionic Valve* in which the filament contains special substances which cause it to emit electrons at a much lower temperature than the original tungsten filaments. The valves to which this name applied were run with the filaments at a dull red heat, but later valves are worked at a lower temperature still, giving no visible glow. See THORIATED FILAMENT and OXIDE COATED FILAMENT.

Dumb Aerial. A closed non-radiating oscillating circuit, having the same oscillation frequency as that of the main aerial, which is connected to the oscillator during the spacing periods in signalling to keep it constantly loaded.

Dummy Aerial. See ARTIFICIAL AERIAL.

Duodynatron. A form of *Dynatron* in which an additional grid oscillating circuit produces a second series of oscillations of different frequency from that of the main oscillations.

Duolateral Coil. A form of inductance coil used in wireless receiving sets, wound in a similar manner to a *Honeycomb Coil*, but with the conductors of alternate layers in one direction occupying intermediate positions instead of lying one over the other.

Duperrey's Lines. Lines on a magnetic map indicating the direction of the magnetic meridian, i.e. Lines of Magnetic Longitude.

Duplex: Bridge, Combination and Differential. See BRIDGE DUPLEX, COMBINATION DUPLEX, etc.

Duplex Catenary Suspension. See DOUBLE CATENARY SUSPENSION.

Duplex Dialling. A system of *Dialling* employing both conductors of a

telephone circuit separately, each with an earth return, with batteries at the opposite ends of the line.

Duplex Protective System. A protective system for interconnecting lines upon *Directional Relays* in which the pilot wire only carries non-quantitative signals and their number is reduced to a minimum by employment of a similar system to that in Duplex telegraphy.

Duplex (Telegraph) System. A telegraph system in which two messages can be sent, one in each direction, simultaneously over the same line.

Duplex Winding. See MULTIPLEX WINDING.

Duplex Wireless Telephony. *Wireless Telephony* arranged for simultaneous transmission and reception in both directions by the use of two different wave-lengths or otherwise.

Duplicate Feeder. See PARALLEL FEEDER.

Dust Core. An iron core for inductances in telephone lines (see PUPIN COILS, etc.) in which eddy current and hysteresis losses are negligible; made by compressing a mixture of shellac and ground electrolytic iron, with the grains covered with zinc. Cf. FERROCART.

Dust Figures. See LICHTENBERG FIGURES.

Dust Oscillogram. A record from a *Cathode Ray Oscillograph* with a screen of insulating material upon which the moving electron beam has made a trace in the form of a negative charge rendered visible by dusting with an *Electroscopic Powder*.

Dust Proof Switchgear, etc. Switchgear and other apparatus so enclosed as to prevent the entry of dust and other suspended matter in the air, for use in such situations as textile factories.

Duty Cycle. The cycle of operations (starting, running and stopping) which a motor on intermittent duty performs each time it runs.

Duty Cycle Factor. The ratio of the equivalent constant current during a duty cycle to the steady running current of a motor.

Dynamic Brake. See RHEOSTATIC BRAKE.

Dynamic Characteristic (of a *Thermionic Valve*). A *Characteristic* relating to working conditions.

Dynamic Condenser. See **ROTARY CONDENSER.**

Dynamic Electricity. An expression occasionally used for electric currents as opposed to *Static Electricity*.

Dynamic Loud Speaker. See **MOVING COIL LOUD SPEAKER.**

Dynamo. A machine in which mechanical power is converted into electrical energy by the movement of conductors in a magnetic field. Commonly limited to generators of continuous current and not alternating current. Cf. **ALTERNATOR.**

Dynamo: Arc-Lighting, Compound-Wound, Constant Current, Constant Voltage, Electro-plating, Ironclad, Multipolar, Noeggerath, Overttype, Plating, Series-Wound, Shunt-Wound, Three-Wire, Train-Lighting, Turbo, Undertype, and Unipolar. See **ARC-LIGHTING DYNAMO**, **COMPOUND WOUND DYNAMO**, etc. See also references under *Generator*.

Dynamo-Electric Machinery or Machines. All machines in which mechanical and electrical energy are converted one into the other, i.e. all classes of generators, motors, rotary converters, etc.

Dynamometer. Originally an instrument for measuring mechanical torque, but applied to a particular class of electrical instrument or *Electrodynamometer*, in which currents, voltages or the product of both are measured by the force between a fixed and a moving coil. Strictly, it should only include such instruments for electric power measurements, i.e. *Wattmeters*. See **SIEMENS AND WEBER ELECTRO-DYNAMOMETERS.**

Dynamometer: Electro-, and Zero Type. See **ELECTRO-DYNAMOMETER** and **ZERO TYPE DYNAMOMETER.** See also references under **ELECTRO-DYNAMOMETER.**

Dynamometer Type Measuring Instruments. Instruments depending for their action upon the forces between fixed and moving coils without iron cores. (Also called *Electrodynamic Instruments*.) See **DYNAMOMETER**, cf. **INDUCTION INSTRUMENTS.**

Dynamometer Type Wattmeter. A wattmeter with a fixed current coil and a spring suspended moving voltage coil, usually in series with a high resistance, without iron cores, indicating by direct deflection.

Dynamotor. A converter with a single field and two armature windings on the same or separate cores; also occasionally used for a machine which sometimes acts as a dynamo and sometimes as a motor.

Dynamotor, Ringing. See **RINGING DYNAMOTOR.**

Dynaphone (1) A form of telephone receiver in which the forces or the diaphragm are partly due to the action of eddy currents induced therein. (2) An electrical musical instrument employing *Kipp Oscillations*.

Dynatron. A form of *Thermionic Valve* used as an oscillator having a negative current-voltage characteristic.

Dynatron Oscillations. Oscillations produced in thermionic valve circuits in virtue of a negative current-voltage characteristic.

Dyns. The unit of mechanical force, which, applied to a mass of one gramme, produces an acceleration of one centimetre per second per second.

E]

E. Symbol for *Electromotive Force* and *Illumination*, and in diagrams to represent an earth connection.

Ear. The grooved metal fitting attached mechanically or by solder to an overhead trolley wire, which it supports and keeps in line.

Earth. A connection with the earth, which behaves as a great conductor; either accidental, causing harmful leakage currents or dangerous differences of potential, or intentional, as for allowing a return path for telegraph currents, etc., or for ensuring that all accessible metal parts of electrical apparatus shall remain at earth potential, for the sake of safety. The word is commonly used both as a noun and as a verb, meaning to make an earth connection. A circuit connected to earth is said to be "earthed." The word (*ground*) is also used in the same sense (particularly in America). A highly conductive earth connection would be called a "bad earth" from the first point of view, and a "good earth" from the second.

Earth: Dead, Intermittent, Partial, Receiving, Sea and Transmitting. See DEAD EARTH, INTERMITTENT EARTH, etc.

Earth Coil. A pivoted coil of large diameter used for measurement of the earth's magnetic field or for standardisation of magnetic testing apparatus by reversing its position suddenly in the earth's field, and observing the throw of a ballistic galvanometer connected to it.

Earth Conduction Telegraphy. A system of short distance telegraphy without line wires in which currents are passed through the earth from one earth plate to another comparatively near together at the transmission station and detected by the small potential difference

produced between two earth plates in the receiving apparatus.

Earth Connection. See EARTH.

Earth Currents. (1) Currents due to natural causes within the earth, affecting terrestrial magnetism, causing magnetic storms, etc. (2) *Return, Fault, Leakage*, or *Stray* currents from electrical installations of any kind passing through the earth.

Earth Detector. An instrument for revealing the existence of leakage currents to earth. See LEAKAGE INDICATOR.

Earth Inductor. See EARTH COIL.

Earth Inductor Compass. A course indicator for aircraft, consisting of the equivalent of a d.c. dynamo in the earth's field. When on a course the bushes are set to give no deflection on a galvanometer connected thereto. Any deviation from the course will cause a deflection right or left.

Earth Leakage Relay. A relay coming into action on the current in an earth connection exceeding a predetermined value.

Earth Magnetism. See TERRESTRIAL MAGNETISM.

Earth Overlap Test. A test used to locate a high resistance fault in a submarine cable which can still be signalled over. Resistance measurements (R) are taken from either end with the opposite end earthed and with resistance (L) added to make the results from both ends equal, i.e. to bring the fault electrically to the centre of the cable. The distance of the fault (in ohms) is then $(L-R)/2$.

Earth Plate. A large plate of metal buried in the ground to make a good conductive earth connection.

Earth Potential. The potential of the earth, owing to its large capacitance can be regarded as always remaining at zero value.

Earth Return. The return path for a current through the earth.

Earth Return (Telegraph) Circuit. A circuit completed by an *Earth Return*.

Earth Screen or Shield. (1) In a transformer: An earthed sheet metal screen between the primary and secondary windings of a transformer. (2) In a cable: A conducting layer over the insulation, earthed and connected to the sheathing, if any. (3) In wireless telegraphy: see SCREENED ARRIVAL.

Earth Terminal. A terminal provided on a piece of apparatus for making a connection to earth.

Earth Wire. (1) A wire making an earth connection. (2) A wire, connected to earth, running above the conductors in h.t. transmission lines, to minimise the effects of lightning, to conduct earth currents in case of leakage and in other ways to lessen interference with neighbouring communication circuits.

Earthed Circuit. A circuit intentionally connected to each at some point.

Earthed Concentric Wiring. See CONCENTRIC WIRING.

Earthed Conductor. A conductor connected to earth.

Earthed Neutral. The neutral point of a three phase star connected system or apparatus, or the middle wire of a three-wire system, when connected to earth.

Earthed Pole. One pole of a circuit intentionally connected to earth.

Earthed Switch. A switch with provision for connecting all metal parts other than the conductors, to earth.

Earthed System. A system of electricity supply in which one conductor, e.g. the middle or neutral wire, is purposely connected to earth.

Earthed Terminal. The terminal of a piece of apparatus connected to earth.

Earthed Wiring. Wiring in which the return circuit is connected to earth.

Earthenware Conduit or Ducts. Conduits or ducts for the reception

of cables made of earthenware in short lengths with one or several channels.

Earthing Auto-Transformer. A term sometimes used for a *Neutral Auto-Transformer* when the neutral point formed thereby is earthed.

Earthing Cable Bond. A *Cable Bond* for earthing the sheathing of a cable.

Earthing Clip. A clip, for affixing to conduit tubes to make connection to earth, usually with some device which scratches off the enamel to make a metallic connection when the clip is screwed up tight.

Earthing Coil. A resistance connected to earth which is sometimes switched in to replace one of the batteries and keys in the *Quadruplex* telegraph system, to facilitate obtaining a balance.

Earthing Core. An additional core in the *Shore-End* of a modern submarine cable, extending from the shore to a suitable distance out to sea where it is connected to the sheathing to form a *Sea Earth*.

Earthing Device, Cardew. See CARDEW EARTHING DEVICE.

Earthing Grips. Appliances for making a satisfactory connection between the *Earth Wires* of an installation and water pipes, etc.

Earthing Inductor, or Reactor. (1) A *Reactor* through which connection to earth is made to limit the possible fault current and to compensate for the leading current to earth due to the capacitance of the system. (2) See EARTHING AUTO-TRANSFORMER.

Earthing Resistance. A resistance placed in the earth wire circuit for limiting the current to earth on the occurrence of a fault.

Earthing Terminal. See EARTH TERMINAL.

Eccentric Poles. Poles in which the curve of the face is not concentric with that of the armature, in order to produce an increased air gap at the pole tips, to obtain better approximation to a sinusoidal flux distribution.

Eccentricity of Rotor. The mounting of a rotor purposely a little out of centre to allow the consequent asymmetrical magnetic pull to

take a portion of the weight, or to allow for wear in the bearings.

Echo. Although more commonly used for the repetition of a sound due to reflection of acoustic waves, the term "echo" is also used for effects depending on the reflection of electric waves. See also WIRELESS ECHO.

Echo, Wireless. See WIRELESS ECHO.

Echo Depth Sounding. A system of taking deep sea soundings in which the time interval between a sound just below the surface and the receipt of the echo from the bottom is measured. In the earlier instruments microphones are employed, one of which causes the starting of an indicating disc, while the other causes its arrest on receipt of the echo. In later apparatus a piezo-electric oscillator is employed both to initiate and to detect the waves and continuous recording arrangements are used. See also SUPERSONIC SOUNDING, and MAGNETOSTRICTION ECHO DEPTH RECORDER, and cf. RADIO-ACOUSTIC POSITION FINDING.

Echo Signals. See ECHO.

Echo Suppressor. A device for preventing interference of reflected waves over long loaded telephone lines, especially when working through repeaters.

Economiser (in an Arc Lamp). A hood or inverted bowl of refractory material over the tips of the carbons in an arc lamp, which causes slower burning away of the electrodes by retaining the gaseous products of combustion and preventing the access of oxygen, and incidentally improves the distribution of the light, by reflecting a portion of that given out in an upward direction.

Economy Resistance. A resistance inserted into the circuit of a solenoid, or other electromagnetic device requiring a heavy initial actuating current, to reduce the current to a lower value for holding on (or off) purposes.

Eddy Current Brake. (1) A brake for providing a retarding torque, or for horse power measurement,

in which the torque is due to the reaction of currents induced by an electromagnet or permanent magnet, in a moving mass of metal. (2) A railway or tramway brake in which the retarding force is produced by the induction of eddy currents in the rail by a magnet on the vehicle. (3) In another form of eddy current rail brake used in railway sorting yards, the magnet is fixed to the truck with its pole pieces on either side of the rail so that the flux passes through the rim of the wheel.

Eddy Current Loss. The portion of the energy losses in machines, apparatus, etc., due to eddy currents.

Eddy Current Speed Indicator. A form of speed indicator in which a rotating disc deflects a pivoted spring controlled magnetic needle or system, or *vice versa*, by means of the reaction of the eddy currents produced in the disc.

Eddy Current Transmitter. A telephone transmitter consisting of a disc of aluminium foil vibrating under the influence of the sound waves in a constant magnetic field produced by two slab coils. Suitable connections are made to render the eddy currents induced in the disc available for reproduction.

Eddy Currents. Currents induced by a varying magnetic field in the mass of a solid conductor; sometimes producing energy losses in electrical apparatus and minimised by laminating the mass in question, and sometimes turned to useful account, as in eddy current brakes, etc. (Also called *Foucault Currents*.)

Edge Blocks. Extra blocks of insulating material between and turns of transformer windings where additional insulation is required.

Edge Winding. A form of winding for field coils, etc., composed of flat strip with the bare edges exposed to the air. Such a winding readily dissipates heat and has a good space factor.

Edgewise Instruments. Switchboard measuring instruments in which

the pointer moves in a vertical or horizontal plane at right angles to that of the board, and is bent round so that its point moves over a curved scale. A number of such instruments can be placed side by side in a small space.

Edison Accumulator Cell. An accumulator cell, originated by Thomas Alva Edison, with positive plates made up of thin perforated steel tubes containing nickel oxide with flakes of nickel, and negative plates of steel with pockets containing iron oxide, in an electrolyte of potassium hydrate with a small amount of lithium hydrate. The cell has an average discharge voltage of 1.2 volts and is claimed to have advantage of lightness and durability over the lead cell.

Edison Effect. The fact that if a metal plate be sealed into the bulb of an incandescent lamp, and a galvanometer connected between it and the positive terminal of the filament, a current is seen to flow due to the stream of electrons from the negative electrode, while this is not the case if the galvanometer be connected to the negative terminal.

Edison Screw (E.S.) Cap. A form of lamp cap, used extensively in America, in which the screwed body of the cap itself is one terminal and a central contact plate is the other (about 1 in. in diameter). This size is sometimes called *Medium Edison Screw Cap*. Cf. GOLIATH, SMALL, and MINIATURE EDISON SCREW CAPS.

Edison Screw Holder. A lamp holder for incandescent lamps with Edison Screw terminals in which the screwing home of the lamp makes the necessary contacts.

Edison Storage Battery. See EDISON ACCUMULATOR CELL.

Edison (Loud Speaking) Telephone. A Telephone Receiver in which the movements of the diaphragm were controlled by the variable friction produced by variations in the current between a revolving disc of chalk and a brass band moistened with a chemical solution. (Originally called *Electromotograph*.)

Eel (Electric). The Surinam Eel (*Gymnotus Electricus*), which has the power of giving powerful electric shocks to its enemies from a special organ in its body. See also RAY, SILURUS, TRICHINUS and TETRAODON.

Effective A.C. Resistance. See EFFECTIVE RESISTANCE.

Effective Capacitance. The equivalent of the capacitance of a condenser under alternating a.m.f., including correction for the effect of power losses due to *Dielectric Hysteresis*.

Effective Current, E.M.F., etc. The Root Mean Square value of an alternating current, a.m.f., etc.

Effective Height (of an Aerial). The height of an ideal single vertical aerial without capacitance or resistance which would produce the same radiation effect as the aerial under consideration. Symbol: h_e .

Effective Range (of Measuring Instruments). That part of the whole range over which a practical degree of accuracy can be obtained.

Effective Resistance. The resistance of a circuit, or part of a circuit, to an alternating or pulsating current as measured by dividing the total losses therein by the square of the r.m.s. value of the current. Cf. OHMIC RESISTANCE.

Effective Voltage. See EFFECTIVE E.M.F.

Efficiency. The ratio of the useful output of a piece of apparatus to the total input; usually expressed as a percentage. See SPECIFIC CONSUMPTION. Symbol: η .

Efficiency: Ampere-Hour, Apparent Electrode, Luminous, Overall, Plant, Radiant, Radiation, and Watt-Hour. See AMPERE-HOUR EFFICIENCY, APPARENT EFFICIENCY, etc.

Effluve. A discharge similar to Corona effect, used in electrotherapy to stimulate the skin.

Effluvium (Electric). The quasi-material *Emanation* which was formerly thought to be given out by electrified bodies and accounted for their power of attraction.

Egg (Electric). An early form of glass vessel due to Faraday with electrodes for the study of electric discharges in gases at low pressures.

E.H.P. *Electrical Horse-Power.*

E.H.T. *Extra High Tension.*

Eikmeyer Coil. The original pattern of former-wound armature coil which can be slipped complete into the slots and gives a compact arrangement of end connections.

Einhoven Galvanometer. A galvanometer in which the movement of a single current-carrying filament in a very strong magnetic field is observed under a microscope or otherwise. (Also called *String Galvanometer.*)

"E" Layer. See KENNELLY-HEAVY-SIDE LAYER.

Elastance. A name sometimes used for the reciprocal of *Capacitance*.

Elasticity. A name sometimes used in *Permittivity*. See ELASTICITY.

Elbow. A right-angle *Bend* of short radius for connecting two lengths of conduit tube. Sometimes called a sharp bend.

Electricity. See ELASTIVITY.

Electrometer. An obsolete name for a *Reversing Switch*.

Electret. A term sometimes used for a rod, etc., of dielectric material permanently charged at one end positively, and at the other negatively; analogous to a magnet. It is claimed that such "electrets" can be made by allowing a tube of fused dielectric to solidify in a powerful electrostatic field, and that the charge can be retained for long periods. If an "electret" be broken, each portion shows electrostatic polarity. The effect has been explained by the assumption that the ions are held in fixed positions on the solidification of the dielectric.

Electric.* (1) Adjective: Worked by or pertaining to *Electricity*. (2) Noun: A material such as amber, which when rubbed acquires an electric charge. (Derived from the Greek word *ἤλεκτρον*, meaning amber, which was the first material to be observed to have this property.)

Electrical.* Adjective of nearly the same meaning as *Electric*, but a

* For terms beginning with "Electric" or "Electrical" see references under the following word, e.g. for *ELECTRIC BELL* see *BELL (Electric)*.

little more general in its application; more commonly, but not universally, used before a vowel.

Electrician. A person engaged in the construction of, or care of, electrical apparatus or installations.

Electricity. The manifestation of a form of energy probably due to the separation and independent movement of certain constituent parts of atoms called *Electrons*. If these electrons are regarded as consisting of electric charges only, then electricity may be defined as "the stuff of which matter is made."

Electricity: Animal, Atmospheric, Dynamic, Frictional, Galvanic, Negative, Piezo-, Positive, Pyro-, Quantity of, Resinous, Statical, Thermo-, Tribo-, Vitreous, and Voltaic. See ANIMAL ELECTRICITY, ATMOSPHERIC ELECTRICITY, etc.

Electricity Meter. See SUPPLY METERS.

Electricity Works. A generating station for the supply of electrical energy on a large scale.

Electrification. The production of an electric charge in a body. Used also in popular language for the conversion of a railway, works, etc., to electric driving, or in general for the adoption of electrical methods.

Electrify. To charge with *Electricity*. See also popular use of *ELECTRIFICATION*.

Electron. A term used by Lord Kelvin for a hypothetical indivisible unit of electricity somewhat similar to the later postulated *Electron*.

Electrise. See ELECTRIFY.

Electro. Abbreviation of *Electro-type*; used in the printing trades to signify a block made by depositing copper in a matrix or mould taken from original blocks, type, etc., and filling up the back of the thin copper shell thus formed with easily fusible metal.

Electro-Adhesion. See ELECTRO-STATIC ADHESION.

Electro-Adhesion Telephone. A telephone receiver in which the pull on the diaphragm is varied by the alteration of the *Electrostatic Adhesion* between a rotating cylinder and a brake band.

Electro-Analysis. See **ELECTROLYSIS**.

Electro-Ballistics. Measurement of speed of projectiles by electrical methods.

Electro-Biology. The science of the electric phenomena of living organisms.

Electro-Bioscopy. The application of an e.m.f. to an animal body to detect signs of life by the production of muscular contractions.

Electrobus. Popular name for an electric omnibus driven by accumulators.

Electro-Camera. See **ELECTRO-PHOTOGRAPHY**.

Electrocapillarity. The alteration of the surface tension between two liquids in contact due to an electric potential gradient. See **CAPILLARY ELECTROMETER** and **ELECTRO-CAPILLARY MICROPHONE**.

Electro-Capillary Microphone. A microphone in which the alteration of the depth of immersion of a capillary tube dipping into mercury is altered by the action of the sound waves, causing a varying e.m.f. between the mercury and the electrolyte by what appears to be the converse of the action in an *Electrocapillary Electrometer*.

Electro-Cardiograph. An electrically worked instrument for recording the action of the heart in an apparatus at a distance from the patient by means of the minute currents induced by the action of the heart itself.

Electro-Cautery. Surgical operation by means of an electrically heated wire.

Electro-Cement. Cement made in the electric furnace by the addition of lime to molten slag.

Electro-Chemical Condenser. See **ELECTROLYTIC CONDENSER**.

Electro-Chemical Equivalent. The amount of a substance liberated electrolytically by the passage of one ampere for one second.

Electro-Chemical Series. A table of metals arranged according to their *Contact Potentials* or those which they produce in a particular electrolyte; those furthest apart in the table giving the greatest difference of potential.

Electro-Chemistry. The science of

the interaction of chemical and electrical phenomena.

Electrochord. See **ELECTRONIC PIANO**.

Electro-Chronograph. See **CHRONOGRAPH**.

Electro-Culture. The improvement in the rate of growth or the yield of crops, vegetables, plants, etc., by electrical means, such as by an electrical field produced by a network of highly charged wires spread above the ground, by earth currents, electrical treatment of seeds or otherwise. Cf. **ELECTRO-FARMING**.

Electrocution. Popular term for the execution of criminals electrically, or death by electric shock generally.

Electrode. A solid conductor by which a current passes to or from a liquid or gas; used particularly of electrolytic apparatus, primary cells, discharge tubes, arc lamps and electric furnaces. See **ANODE**, and **CATHODE**.

Electrode: *Auxiliary, Bare, Bipolar, Cadmium, Calomel, Continuous, Cored, Covered, Focusing, Mercury, Metal, Negative, Normal, Oscillating, Positive, Reflecting, Secondary, Self-baking, Sheathed, and Soederberg.* See **AUXILIARY ELECTRODE**, **BARE ELECTRODE**, etc.

Electrode Boiler. A boiler in which the heating effect is produced by the passage of alternating current through the liquid itself between electrodes and not by resistance elements.

Electrode Cable Detector. An apparatus for locating submarine cable faults by towing a pair of weighted electrodes over the track of the cable while an alternating or interrupted current of audio-frequency is flowing. The electrodes are connected to telephones and amplifiers on board, and a sound can be heard when near a fault on the cable.

Electrode Efficiency. The ratio of the quantity of a metal electrodeposited to the quantity theoretically deposited according to *Faraday's Laws*.

Electrode Potential. The difference of potential between an electrode and the electrolyte in an electro-

- lytic cell, sometimes called *Single Potential*.
- Electrodeless Discharge.** A luminous discharge in a partially exhausted tube not provided with electrodes obtained by inducing an o.m.f. by an alternating or rapidly varying field.
- Electro-Deposit.** A deposit made by *Electrolytic* means.
- Electro-Deposition.** Depositing metals, etc., by electrolytic means in the form required, as in electroplating with gold, silver, nickel, copper, etc., electrotyping or the manufacture of copper tubes, etc., electrolytically. (Substances other than metals can also be electro-deposited when suspended in a finely-divided state in a liquid. India-rubber has been deposited in this way.)
- Electro-Dynamic.** (1) Pertaining to electric currents, as opposed to *Electrostatic*. (2) Relating to mechanical forces between conductors carrying currents.
- Electro-Dynamic Instruments.** See DYNAMOMETER TYPE INSTRUMENTS.
- Electro-Dynamism.** See ELECTRO-DYNAMICS.
- Electro-Dynamometer.** See DYNAMOMETER.
- Electro-Dynamometer : Siemens and Weber.** See SIEMENS ELECTRO-DYNAMOMETER and WEBER ELECTRO-DYNAMOMETER.
- Electro-Endosemose.** See ENDOMOSE.
- Electro-Engraving.** See ENGRAVING (Electric).
- Electro-Extraction.** Recovery of a metal from its compounds by *Electrolytic* methods.
- Electro-Facing.** The electro-deposition of a protective coating of a harder metal on a base of softer metal, e.g. coating of stereotype plates with nickel.
- Electro-Farming.** A name suggested for all operations connected with farming carried out with the aid of applications of electricity.
- Electro-Filter.** See PRECIPITATION (Electrical).
- Electro-Forming.** The production of metallic articles, etc., by *Electro-Deposition*. See ELECTROTYPING.
- Electro-Galvanising.** The deposition of a protective coating of zinc on metal objects such as boiler tubes by electrolytic means. (Sometimes called *Cold Galvanising*.)
- Electro-Gilding.** Coating with gold by *Electro-Deposition*.
- Electro-Goniometer.** A name sometimes used for a *Phase-Indicator*.
- Electrogram.** A chart of variations of atmospheric potential gradient, made by an *Electrograph*.
- Electrograph.** (1) A recording electrometer for the investigation of the potential gradient in the atmosphere. (2) An American system of *Photo-Telegraphy* employing an etched original with the etched portions filled up with insulating material.
- Electrographic Orsillograph.** An *Oscillograph* in which the variation of charge along a moving bar subjected to a varying stream of cathode rays is afterwards rendered visible by an *Electroscopic Powder*.
- Electrography.** (1) A term sometimes used for *Electrotyping*. (2) A process of picture transmission in which the receiver contains a synchronously moving insulated plate exposed to a modulated electric field producing a distribution of charge which can be made visible by dusting the plate with lycopodium powder.
- Electro-Kinetic Transformer.** A transformer with a rotating armature, e.g. a *Direct Current Transformer*.
- Electro-Kinetics.** The science of electricity in motion, i.e. of electric currents.
- Electrolier.** A pendant electric light fitting carrying a number of lamps (analogous to chandelier).
- Electrology.** The science of electricity and its application, used particularly in the case of *Medical Electrology*.
- Electrolyse.** To decompose chemically by the passage of an electric current.
- Electrolyser.** An apparatus by which electrolytic decomposition is effected.
- Electrolysis.** The chemical decomposition of a substance such as a liquid by the action of a current which passes through it.
- Electrolyte.** A substance which

- undergoes chemical decomposition when a current is passed through it, such as the liquid in a primary, secondary, or electrolytic cell.
- Electrolyte: Amphoteric, and Solid.** See **AMPHOTERIC ELECTROLYTE**, and **SOLID ELECTROLYTE**.
- Electrolytic Arrestor.** See **ELECTROLYTIC LIGHTNING ARRESTER**.
- Electrolytic Battery Regulator.** A group of electrolytic cells in series, connected in parallel with a battery for automobile lighting, etc., which allows a current to be by-passed as soon as a certain voltage is reached, in order to prevent an excessive current passing through the battery when it is nearly fully charged, without interfering with the strength of the changing current when the battery voltage is low.
- Electrolytic Bleach.** A solution prepared by the electrolysis of sea water or other chlorides and consisting principally of hypochlorites, which has a powerful bleaching and disinfecting action.
- Electrolytic Bleaching.** Bleaching by the electrolytic production of a bleaching agent, see **ELECTROLYTIC BLEACH**. In one system, the object to be bleached is moistened by, or immersed in, a suitable electrolyte, and electrodes are brought in contact with the portion to be bleached.
- Electrolytic Cell.** Any vessel fitted with suitable electrodes and containing an electrolyte in which an electrolytic process is carried out.
- Electrolytic Condenser (or Capacitor).** A condenser for alternating current in which the capacitance effect is wholly or partly due to a back e.m.f. of polarisation. In one form, the dielectric is a thin film of a compound of aluminium deposited electrolytically on an aluminium plate; suitable only for low pressures per cell but of considerable capacitance owing to the thin film that can be used. Another form, with a liquid or paste electrolyte, relies more exclusively upon the electro-chemical effect and is used for power factor correction with induction motors, smoothing circuits, etc.
- Electrolytic Condenser, Dry.** See **DRY ELECTROLYTIC CONDENSER**.
- Electrolytic Conduction.** Conduction after the manner of an electrolyte, i.e. in which processions of dissociated portions of atoms, or "ions," carry positive and negative charges in opposite directions to the electrodes.
- Electrolytic Conductor.** A substance which conducts electrolytically.
- Electrolytic Convection.** A term sometimes applied to the initial flow of current which takes place through an electrolyte when an e.m.f. less than that of polarisation is applied, until the opposing e.m.f. has been built up.
- Electrolytic Copper.** Copper of a high degree of purity prepared by *Electro-Deposition*.
- Electrolytic Corrosion.** Corrosion of underground pipes, etc., by the electrolytic action of stray return currents from tramways, etc., through the earth.
- Electrolytic Detector.** (1) An apparatus which shows by the coloration of a solution at one electrode or the other, in which direction an e.m.f. has been applied. See **POLEFINDING PAPER**. (2) A detector of electric waves depending on the rectifying action of an electrolytic cell with minute electrodes.
- Electrolytic Dissociation.** See **IONISATION**.
- Electrolytic Extraction of Metals.** The production of a metal by *Electrolysis* from one of its compounds obtained by some other operation.
- Electrolytic Furnace.** A direct current electric furnace in which the required chemical change is effected electrolytically by the passage of the same current that fuses the charge and maintains it at a high temperature.
- Electrolytic Hydrogen.** Hydrogen prepared by the electrolysis of water; used on an extensive scale in war-time for balloons and airships, in the synthetic ammonia process for the fixation of nitrogen and for other industrial purposes. See **KNOWLES CELL** and **ALLAN CELL**.
- Electrolytic Instruments.** Measuring

instruments depending upon electrolysis for their action, e.g. *Electrolytic Meters*.

Electrolytic Interrupter. An interrupter for use with induction coils, etc., in which the high frequency and regular interruption of the current is effected by conditions of instability at a point in an electrolytic cell where the current density is abnormally high. See SIMON and WEHNELT INTERRUPTERS.

Electrolytic Ionisation. See IONISATION.

Electrolytic Iron. Iron of great purity prepared by electro-deposition; sometimes used where high magnetic permeability is required.

Electrolytic Lightning or Surge Arrester. A lightning or surge arrester consisting essentially of a series of electrolytic condensers in series, formed by a pile of aluminium saucers separated only by a non-conducting film on the surface of each, which has the property of breaking down at a certain voltage (about 400 volts per cell) and conducting a heavy current until the voltage surge has ceased when the punctures in the films reseal themselves.

Electrolytic Magnifier. An apparatus fulfilling a similar function to a *Relay* in cable telegraphy, except that, instead of containing actual contacts, it has a moving system employed to alter the relative positions of the wires dipping into an electrolyte, thus making changes in resistance which affect the balance of the duplex circuits and actuate the receiving apparatus accordingly.

Electrolytic Meter. An electric supply meter in which the quantity of electricity passing is ascertained by measuring the amount of a substance that has been decomposed electrolytically.

Electrolytic Oxygen. Oxygen which has been prepared by the electrolysis of water. See also ELECTROLYTIC HYDROGEN.

Electrolytic Parting of Metals. The separation of two metals forming an alloy by *Electrolysis*.

Electrolytic Rectifier. An apparatus in which alternate half waves of an alternating current are suppressed owing to the unilateral conductivity of certain electrolytic cells, so that a uni-directional current is produced. See NODON VALVE, etc.

Electrolytic Refining. Preparation of pure metals by electro-deposition.

Electrolytic Resistance. The quality of an electrolyte which opposes the passage of a current, measured by the ratio of the applied e.m.f. to the current it produces. Due partly to real ohmic resistance and partly to counter e.m.f.

Electrolytic Solution Voltage. The minimum *Electrode Voltage* with a particular electrode which will just prevent formation of ions.

Electrolytic Valve. See ELECTROLYTIC RECTIFIER.

Electrolytic Water-Tester. See DIONIC WATER TESTER.

Electrolytic Wire Bar. A bar of electrolytic copper (or aluminium) suitable for rolling into a rod for wire-drawing.

Electromagnet. A core of iron, steel, etc., rendered temporarily magnetic by a current flowing in a coil of wire surrounding a part of it. First made by Sturgeon in 1825.

Electromagnet: Alternating, Differential, Figure of Merit of, Iron-clad, Plunger, Polarised, and Tubular. See ALTERNATING ELECTROMAGNET, DIFFERENTIAL ELECTROMAGNET, etc. See also REFERENCES under MAGNET.

Electromagnetic. Pertaining to the magnetic forces due to electric currents.

Electromagnetic Brake. A brake in which the retarding force is produced by friction between two surfaces pressed together by magnetic attraction, either directly or indirectly, as in the form of tramcar brake in which the mechanical drag of the brake magnet on the track rail applies brake shoes to the wheels through suitable gearing.

Electromagnetic Component (of Electric Waves). The component in a plane at right angles to the electrostatic component which produces

a cyclic change of magnetic conditions at a point. It is this component which causes the induction of currents in a *Frame Aerial*.

Electromagnetic Control. Control of switch gear, etc., by the action of electromagnets, solenoids, etc., operated by closing auxiliary contacts at a distance from the main contacts. See **REMOTE CONTROL**, **CONTACTORS**, etc., and cf. **ELECTRO-PNEUMATIC CONTROL**.

Electromagnetic Coupling. See **INDUCTIVE COUPLING**.

Electromagnetic Crack Detector. An instrument in which a strong magnetic flux is passed through the piece of iron or steel to be tested and a liquid containing finely divided magnetic particles in suspension is applied to the surface. If a crack, otherwise invisible, exists, the leakage lines of force cause those particles to adhere where external polarity is produced by the greater reluctance of the crack, and a distinct line is produced indicating its position. See also **FLASH MAGNETISATION**.

Electromagnetic Damping. See **MAGNETIC DAMPING**.

Electromagnetic Generator. A general term for dynamos, alternators, etc., sometimes used to distinguish them from *Electrostatic Generators*.

Electromagnetic Induction. The production of an electromotive force by a change of magnetic flux linking a circuit. Cf. **MAGNETIC INDUCTION** and **ELECTROSTATIC INDUCTION**.

Electromagnetic Inertia. The energy required to start or to stop a current in an inductive circuit.

Electromagnetic Instruments. Measuring instruments, depending for their action on electromagnetic forces upon iron armatures.

Electromagnetic Lens. An *Electron Lens* in which the focusing is effected electromagnetically.

Electromagnetic Microphone. See **ROUND-SYKES MAGNETOPHONE**.

Electromagnetic Retroaction. Retroaction in a wireless receiving set in which the coupling between the plate and grid circuits is electromagnetic (inductive). Cf. **ELECTROSTATIC RETROACTION**.

Electromagnetic Spectrum. The whole of the known range of electric waves, from the longest employed in wireless telegraphy to the shortest *Gamma Rays*.

Electromagnetic Switch. See **ELECTROMAGNETICALLY OPERATED SWITCH**.

Electromagnetic Theory of Light. The recognition of the identical nature of light and electric waves. Established theoretically by Clark Maxwell before electric waves had been observed experimentally.

Electromagnetic Units. The system of absolute electrical units upon which the practical units (volt, ampere, etc.) are based; derived from the fundamental units of length, mass and time (the centimetre, the gramme and the second), and based upon a unit strength of magnetic pole which exerts unit mechanical force on an equal pole at unit distance. Cf. **ELECTROSTATIC UNITS**.

Electromagnetic Waves. See **WAVE (Electric)**, **RADIATION**, etc.

Electromagnetically Operated Switch. A switch opened and closed by the action of electromagnets or solenoids. See **CONTACTOR**, **REMOTE CONTROL** and **ELECTROMAGNETIC CONTROL**. Cf. **ELECTRO-PNEUMATIC CONTROL**.

Electromagnetics. The science of *Electromagnetism*.

Electromagnetism. The whole science of the connection between magnetism and electric currents.

Electro-Massage. Massage combined with electrical curative treatment.

Electromatic Traffic Signalling. A system of traffic signalling in which the passage of an approaching vehicle over a strip in the road completes a relay circuit which gives it priority over vehicles approaching from another direction.

Electromechanical Brake. A brake employing partly electromagnetic and partly mechanical forces, e.g. the Maley tramcar brake in which the drag of a magnetised track shoe causes the mechanical application of further track brake shoes.

Electrometallisation. The production of a decorative or protective metallic coating electrolytically on a non-metal.

Electrometallurgy. The industrial working of metals by electrical processes, including *Electro-deposition*, *Electrolytic Refining* and operations in the *Electric Furnace*, such as aluminum smelting, steel manufacture, etc.

"Electrometals" Furnace. A form of electric furnace for iron melting, etc., in which the main heating effect is produced by the passage of the current through the charge itself.

Electrometer. An instrument for measuring potential by the electrostatic attraction between fixed and moving conductors, or other action not depending on the flow of a current.

Electrometer : Absolute, Attracted Disc, Capillary, Dolezalek, Filament, Kelvin, Portable, Quadrant, and Tachometric. See ABSOLUTE ELECTROMETER, ATTRACTED DISC ELECTROMETER, etc.

Electrometer Gauge. A miniature attracted disc electrometer connected to the needle of a quadrant electrometer used to ascertain whether the needle is sufficiently charged.

Electrometer Valve. A type of *Thermionic Valve* for amplification of input to measuring instruments, etc., designed for extremely small grid current.

Electrometric Analysis. Quantitative chemical analysis carried out by electrolytic means.

Electrometric Dynamometer. A term sometimes used for a dynamometer for measuring mechanical forces depending upon small movements of part of one electrode of a quadrant electrometer.

Electromobile. An electrically propelled automobile.

Electromotive Force (E.M.F.) That which tends to cause an electric current in a circuit, by producing a difference of potential, e.g. the effect of the chemical action in a *Primary Cell*; measured in practice in *Volts*. Symbol *E*. Cf. DIFFERENCE OF POTENTIAL, TENSION, PRESSURE, etc.

Electromotive Force : Applied, Back, Counter, Effective, Impressed, and Induced. See APPLIED ELECTROMOTIVE FORCE, BACK ELECTROMOTIVE FORCE, etc.

Electromotive Intensity. Potential difference per unit length, i.e. *Potential Gradient*, also called *Field Intensity*.

Electromotograph. The name originally given to the *Edison Loud Speaking Telephone*.

Electromotor. A term now used for an apparatus for converting electrical energy into mechanical work, but used by Faraday for a source of electromotive force. See MOTOR.

Electro-muscular. Relating to action of muscles caused by an electric current.

Electromyograph. An instrument for recording electrical changes in muscles.

Electron. (1) The Greek word for amber from which the word Electricity is derived. (2) The smallest negative charge that is believed to be able to exist by itself, and being that carried by, or consisting of, one of the detachable constituents found in all atoms. See NUCLEAR THEORY. The transference of electrons from one atom to another and their independent movement constitute the phenomena of electricity. The charge carried by an electron is equal to 4.774×10^{-10} electrostatic unit, or 1.592×10^{-19} coulomb. The mass of an electron 9×10^{-28} gramme, or $1/1800$ that of an atom of hydrogen.

Electron : Positive, Primary, Satellite, and Secondary. See POSITIVE ELECTRON, PRIMARY ELECTRON, etc.

Electron Camera (Baird). A television camera in which an optical image causes electron emission from a photo-electric screen. This is focused and deflected, so that the "electron image" produced is scanned by a fixed point, the varying potential of which controls the modulation.

Electron Diffraction. The effect similar to diffraction of light which produces on a photographic plate a series of rings when a concen-

trated beam of cathode rays which has passed through a very thin metallic film falls on it. This effect appears to indicate that the nature of moving electrons partakes of that of wave motion as well as that of discrete particles.

Electron Discharge. See ELECTRONIC DISCHARGE.

Electron Discharge Lamp. A *Discharge Tube Lamp*, such as a *Neon Lamp*.

Electron Discharge Tube. See ELECTRON TUBE.

Electron Gun. A name sometimes used for the whole of the apparatus used for generating and focusing the electron jet or beam in a cathode ray or similar tube.

Electron Image Tube. An electron tube with a cathode of considerable surface covered with photoelectrically sensitive material upon which an optical image is thrown. This causes corresponding omission of electron streams which can be focused by systems of electron lenses upon a fluorescent screen. See also ELECTRON TELESCOPE and ELECTRON MICROSCOPE.

Electron Jet. A concentrated beam of *Cathode Rays*.

Electron Jet Instruments. Instruments, such as the *Cathode Ray Oscillograph*, employing an *Electron Jet* deflected by variable electric or magnetic fields as a "pointer."

Electron Lens. An appliance for spreading, concentrating or otherwise focusing a beam of projected electrons by the action of an electric or magnetic field. See also ELECTRON MICROSCOPE.

Electron Microscope. An apparatus by which the structure of a body can be examined by spreading an electron beam emitted therefrom by electrostatic or electromagnetic deflection.

Electron Multiplier. A highly exhausted tube with an anode in the centre and a flat cold cathode at each end. An electron from a photoelectric or other source impinging upon one cathode causes emission of secondary electrodes at a high speed (due to the high voltage maintained between the electrodes). These are caused by a focusing coil to miss the anode

and to impinge upon the second cathode producing omission of further secondary electrons. Thus the action is cumulative and a considerable amplifying effect is produced.

Electron Optics. The study of the behaviour of beams or jets of projected electrons as deflected by electric or magnetic fields equivalent to lenses.

Electron Power Tube. See THERMIONIC OSCILLATOR.

Electron Telescope. An apparatus for seeing through haze, etc., by infra-red rays in which an infra-red ray image is formed by optical lenses on the cathode of an *Electron Image Tube* by which it is rendered visible.

Electron (or Electronic) Theory. The theory which explains all electrical phenomena by the interatomic transfer or independent movement of electrons.

Electron Tube and Electron Valve. A *Discharge Tube* such as a *Thermionic Valve* or "*X*" *Ray Tube* in which there is a sufficiently high vacuum for the effect to be due to streams of electrons and not of gaseous ions, e.g. a *Kenotron* or a *Coolidge Tube*, often used indiscriminately for any Thermionic Valve, Cathode Ray Tube, etc. Cf. GAS DISCHARGE TUBE.

Electron Valve. An *Electron Tube*, the application of which depends upon its unilateral conductivity.

Electron Waves. Groups of waves which, according to recent theory, accompany the movement of electrons. Their presence was predicted mathematically by de Broglie and confirmed by diffraction observations.

Electron-Coupled Frequency Changer. A valve in which a single stream of electrons is first made to oscillate with a locally controlled frequency, and the frequency of the received signal is superposed upon it, producing a heterodyne intermediate frequency; either of the *Heptode* or *Octode* type.

Electronode. A musical instrument similar in principle to the *ETHEROPHONE*, but with the volume control actuated by a foot pedal.

Electronegative. Having the property

- of being attracted to the positive pole of an *Electrolytic Cell*. Cf. **ELECTRO-POSITIVE**.
- Electronic Cell.** A *Primary Cell* consisting of two dissimilar plates, e.g. copper and zinc, the space between which is occupied by radio-active material.
- Electronic Clouds.** See **HEAVISIDE LAYER**.
- Electronic Discharge.** A discharge in a very highly exhausted tube consisting entirely of electrons without gaseous ions, e.g. in a *Coolidge Tube*.
- Electronic Oscillations.** Oscillations in a circuit connected to a thermionic valve of high frequency owing to conditions of inertia of the electrons of the system; the period of oscillation being dependent upon the time of travel between the electrodes. Cf. **REACTION OSCILLATIONS** AND **DYNATRON OSCILLATION**.
- Electronic Piano.** A piano without a sound board in which the vibrations of each string affect the capacitance of a condenser microphone and produce modulations in a loud speaker circuit.
- Electronic Rectifier.** See **METAL RECTIFIER**.
- Electronic Relay.** A *Thermionic Valve* used as a relay.
- Electronics.** The science of the movements of *Electrons*.
- Electronomy.** A name sometimes given to the study of atomic structure.
- Electro-Optical Rotations.** See **MAGNETO-OPTICAL ROTATIONS**.
- Electro-Optics.** The science of the connection between optical and electrical phenomena.
- Electro-Osmosis.** See **OSMOSIS**.
- Electro-osmotic Purification of Water.** See **OSMOSIS**.
- Electro-Parting.** See **ELECTROLYTIC PARTING OF METALS**.
- Electro-Pathology.** The investigation of pathological conditions by electrical methods of curing disease by electrical means.
- Electropathy.** Curative application of electricity.
- Electrophone.** A name originally given to an early form (Ador's) of telephone transmitter, but later used to signify an auxiliary telephone service whereby subscribers can listen to performances at theatres, etc., by means of special instruments over the ordinary exchange lines, and for certain forms of telephone for the use of the deaf.
- Electrophore.** See **ELECTROPHOROUS**.
- Electrophoresis.** The passage of finely divided bodies (e.g. colloids) through a liquid due to the influence of a difference of potential. See also *Cataphoresis* and *Anaphoresis*.
- Electrophorus.** A single apparatus whereby a charge, originally produced by friction on a plate of insulating material, is made to charge an insulated metal plate presented to it, momentarily earthed and then removed, thus multiplying the original charge indefinitely.
- Electrophorus, Continuous.** See **CONTINUOUS ELECTROPHORUS**.
- Electro-Polar.** An old-fashioned term for the state of polarity of a conductor in which an electrostatic charge is produced by induction.
- Electro-Physiology.** The science of electrical phenomena connected with living organisms.
- Electroplate.** Objects which have been silver- or gold-plated electrolytically.
- Electroplating.** Deposition of coatings of nickel, silver, gold, etc., on metal objects by electrolytic means.
- Electroplating Bath.** See **ELECTROPLATING VAT**.
- Electroplating Dynamo.** A dynamo constructed to give a heavy current at a low voltage as required for electro-deposition.
- Electroplating Vat.** A tank in which objects to be plated are hung, in a suitable electrolyte, so that they form the cathode, with anodes formed by plates of the metal to be deposited.
- Electro-Pneumatic Contactor.** A *Contact* in which the contacts are opened and closed by a compressed air cylinder controlled by electromagnetically actuated valves.
- Electro-Pneumatic Control, Signalling, etc.** Systems in which switches, signals, etc., are worked by compressed air controlled by electrically actuated valves. Cf.

ELECTROMAGNETIC CONTROL AND ALL-ELECTRIC SIGNALLING.

Electro-Pneumatic Rock Drill. A reciprocating rock drill in which the pneumatic cylinder actuating the drill is connected by pipes to a valveless reciprocating air pump driven by an electric motor.

Electropoison. A name formerly given to the combined electrolyte and depolariser of the single fluid bichromate cell.

Electropositive. Having the property of being attracted to the negative pole of an electrolytic cell. Cf. **ELECTRONEGATIVE**.

Electro-Precipitation. A term sometimes used for deposition of colloidal substances by **ELECTROPHORESIS**.

Electropuncture. A method of curative electrical treatment involving the insertion of needles into the part affected to serve as electrodes for the passage of a current.

Electro-Refining. See **ELECTROLYTIC REFINING**.

Electroscope. An apparatus for indicating the presence of a difference of potential by electrostatic means without attempting to measure it accurately. Cf. **ELECTROMETER**.

Electroscope: Condensing. Gold Leaf, and Pith Ball. See **CONDENSING ELECTROSCOPE**, **GOLD LEAF ELECTROSCOPE**, etc.

Electroscopic Powder. A mixture of finely powdered materials which if dusted over a plate acquire charges in rubbing together while falling so that the grains of different material adheres to the differently charged portions of the plate. See **LICHTENBERG FIGURES**.

Electroosmosis. See **OSMOSIS**.

Electro-Sherardising. A variety of the Sherardising process (coating iron or steel with zinc by immersion in a heated vessel containing powdered zinc) in which electric heating is employed.

Electrostatic. Pertaining to electric Potentials, Charges, etc., and to the forces due to them, i.e. to effects of what may be described as electricity at rest, as opposed to *Electro-Dynamic*.

Electrostatic Adhesion. The adhesion of one substance to another

in contact with it by electrostatic attraction. This adhesive force can be made very strong even in cases where only a moderate difference of potentials is permitted to exist between the bodies owing to their contact resistance, on account of the almost infinitely small distance between them. The changes of adhesion produced in this way can be practically utilised to actuate telephones, relays and other apparatus. (Also called *Johnsen-Rahbek Effect*.)

Electrostatic Attraction and Repulsion. Mechanical forces between bodies carrying unlike and like charges respectively.

Electrostatic Capacity. See **CAPACITANCE**.

Electrostatic Charge. See **CHARGE**.

Electrostatic Cohesion. See **ELECTROSTATIC ADHESION**.

Electrostatic Component (of Electric Waves). The component at right angles to the *Electromagnetic Component*, i.e., usually in a vortical plane, which produces a cyclic change of electrostatic conditions at a point and thus causes oscillations of potential between a receiving aerial and earth.

Electrostatic Coupling. The association of circuits one to another by a connection involving electrostatic action, e.g. through condensers. Cf. **CONDUCTIVE** and **INDUCTIVE COUPLING**.

Electrostatic Error (in Wireless Direction Finders). The result of stray capacitance-coupling between the field coils and the search coil. Avoidable by interposition of an earthed shield.

Electrostatic Field. A region where forces are exerted due to the presence of electric charges. (Also called *Electric Field*.) Cf. **MAGNETIC FIELD**.

Electrostatic Field Strength. See **FORCE (Electric)**.

Electrostatic Flux. The number of *Unit Electrostatic Tubes of Force* passing through a given cross-sectional area in an electrostatic field. Symbol: Ψ .

Electrostatic Flux Density. See **FLUX DENSITY** and **DISPLACEMENT (Electric)**.

Electrostatic Focusing (in a Cathode Ray Tube). The concentration of the *Electron Jet* by a radial electric field. See **IONIC FOCUSING** and cf. **FOCUSING COIL**.

Electrostatic Force. Forces due to the interaction of electric charges. See also **FORCE (Electric)**.

Electrostatic Generator. A machine which produces charges at high potentials when driven mechanically, by an electrostatic process. See **INFLUENCE MACHINE**, **FRICTIONAL MACHINE**, etc.

Electrostatic Induction. (1) The production of a charge owing to the presence of an opposite charge in a neighbouring conductor. (2) A term sometimes used for electric *Displacement* in electrostatic theory.

Electrostatic Instruments. Measuring instruments depending for their action on electrostatic forces.

Electrostatic Kerr Effect. Refraction of a polarised beam of light by a liquid dielectric, such as nitrobenzol, of a charged condenser by an amount depending on the square of the field.

Electrostatic Lens. An *Electron Lens* in which the focusing is effected by an electric field. Cf. **MAGNETIC LENS**.

Electrostatic Machine. See **ELECTROSTATIC GENERATOR** and **ELECTROSTATIC MOTOR**.

Electrostatic Motor. A motor depending for its action on electrostatic attraction and repulsion. Some forms of *Influence Machine* are reversible and can run as electrostatic motors when a difference of potential is applied to them.

Electrostatic Optical Stress. An optical change in glass and other bodies when under dielectric stress whereby double refraction is produced.

Electrostatic Oscillograph. An *Oscillograph* in which the forces acting on the moving system are electrostatic.

Electrostatic Precipitation. See **PRECIPITATION**.

Electrostatic Refraction. See **REFRACTION**.

Electrostatic Retroaction. *Retroaction* in a wireless receiving set in which the coupling between the plate and grid circuits is electrostatic. Cf. **ELECTROMAGNETIC RETROACTION**.

Electrostatic Separator. An apparatus in which materials of different specific inductive capacities are deflected by varying amounts, and are caused to fall in different heaps, when a mixture of them is allowed to fall in a stream in a powerful electrostatic field. Cf. **DIELECTRIC SEPARATOR** and **MAGNETIC SEPARATOR**.

Electrostatic Shield. A metallic shield or screen to prevent instruments, etc., being affected by external electrostatic fields.

Electrostatic Stress. See **DIELECTRIC STRESS**.

Electrostatic Telephone. See **CONDENSER RECEIVER**.

Electrostatic Transformer. An arrangement by means of which an altered voltage can be obtained from an a.c. circuit by coupling through a condenser to each pole. In order to obtain a stable external characteristic, a resonating circuit is connected to the secondary.

Electrostatic Tubes of Force. See **TUBES OF FORCE**.

Electrostatic Units. The system of absolute electrical units derived from the fundamental units of length, mass and time (the centimeter, the gramme, and the second), based on a unit quantity of electricity which exerts unit mechanical force on an equal quantity at unit distance.

Electrostatic Voltage Multiplier. A device for obtaining increased potential by mechanically reducing the capacitance of a charged condenser and causing it to charge a further condenser.

Electrostatic Voltmeter. A voltmeter depending for its action upon the electrostatic action between fixed and moving plates connected respectively to the poles between which the difference of potential is to be measured; resembling the *Quadrant Electrometer* in principle but of more robust construction. See **MULTICELLULAR VOLTMETER**.

Electrostatic Voltmeter, Generating. See GENERATING ELECTROSTATIC-VOLTMETER.

Electrostatic Wattmeter. An instrument of similar construction to the *Quadrant Electrometer*, in which the two sets of fixed plates are connected to the terminals of a shunt carrying the main current, and the moving vane is connected to the other pole of the circuit; used chiefly in alternating current work.

Electrostatics. The science which deals with the phenomena of what may be described as electricity in a state of rest, i.e. charges and potentials as apart from currents.

Electrostenolysis. Electrolysis of certain metals in capillary tubes.

Electrostriction. Deformation of a dielectric by electric stress.

Electro-surgery. The employment of electrical methods in surgical practice.

Electro-synthetic. Causing chemical combination by electrical means.

Electrosynthetic Switch. A remote-control switch actuated by a frequency superposed in the main circuit by a buzzer or otherwise, and responded to by mechanical resonance. Different frequencies are employed for opening and closing the switch.

Electrotaxis. Movement, in response to electrical stimulus, of small organisms.

Electrotechnics and Electrotechnology. The practice and the science of the application of electricity to industry.

Electrotellurograph. Apparatus for the study of *Earth Currents*.

Electrotherapeutics and Electrotherapy. The science and the practice of electrical treatment of disease.

Electrothermal. Pertaining to the production of heat electrically.

Electrothermal Instruments. Electrical measuring instruments depending for their action upon electrical production of heat.

Electrothermancy or Electrothermy. The science of the production of electricity by heat.

Electrothermics. The art of producing heat by electrical means, e.g. in an electric furnace.

Electrotint. A method of producing printing blocks by drawing with varnish on a metal plate, depositing metal electrically on the parts not so covered, and using the mould so produced to cast the block with the lines in relief.

Electrotone. See ELECTROTONUS.

Electrotonic State. An expression formerly applied to describe a state of electrical tension, now designating a modified condition assumed by a nerve when an electric current is passed through it.

Electrotonicity. See ELECTROTONICS.

Electrotonise. To produce *Electrotonus* in a nerve.

Electrotonus. The modified condition assumed by a nerve when a constant current is passed through it. See ANELECTROTONUS, CATELECTROTONUS.

Electrotropism. A tendency of certain vegetable organisms to assume curvature under the influence of an electric current.

Electrotype. A facsimile in relief of an object, made by electrodepositing copper in a mould with a conducting surface, such as a wax impression which has been dusted over with powdered graphite usually limited to the reproduction of printing surfaces. See ELECTRO.

Electrotyper. One who makes ELECTROTYPES.

Electrotyping. The manufacture of *Electrotypes*.

Electrotypist. See ELECTROTYPER.

Electrotypograph. An electrically worked type setting machine.

Electro-vapour Radiator. A self-contained pipe radiator in which steam circulates formed by heating water in the apparatus by an electric immersion heater.

Electrovection. The passage of a liquid, that is being electrolysed, through a membrane.

Electrovital. Having to do with electrical phenomena caused by vital processes.

Electro-Winning. See ELECTRO-EXTRACTION.

Electrum. (1) Latinised form of Greek *electron* (amber). (2) An alloy of silver and gold used by the ancients. (3) A modern alloy

similar to *German Silver* used in the construction of instruments, etc.

Element. One of the electrodes in a primary, secondary, or thermo-electric cell. Sometimes the term is used for the whole of one cell in a battery, e.g. *Voltaic element*.

Element: Heating, Negative and Positive. See **HEATING ELEMENT**, **POSITIVE ELEMENT**, etc.

Element Carrier. A refractory support upon which a *Heating Element* is mounted.

Elevator (Electrical). See **LIFT**.

Eliminator, Battery. See **BATTERY ELIMINATOR**.

Ellipsoid Voltmeter. An instrument for absolute determination of high voltages by observing the deflection of a metallic ellipsoid of accurately known dimensions suspended in the field between parallel plates to which the voltage to be measured is supplied.

Elliptic Hysteresis. The hysteresis obtained from an elliptic form of *B: H Curve*.

Elliptic Polarisation. Limitation of wave action, such as light or other *Electric Waves* at right angles to the direction of propagation, to unequal action in two planes at right angles to each other. Cf. **PLANE** and **CIRCULAR POLARISATION**.

Elongation, Magnetic. See **MAGNETIC ELONGATION**.

Elverson Oscilloscope. An apparatus for detection of vibrations and examination of movements of parts of machinery, etc., by viewing under recurrent flashes of short duration from a neon or other vacuum tube lamp, controlled by a special contact maker.

Emanation (Electric). See **EFFLUVIUM**.

Emanation, Radio-active. See **RADIO-ACTIVE EMANATION**.

Embedded Panel Heating. See **PANEL HEATING**.

Embedded Pilot. A pilot wire for actuating protective gear embedded in an overhead earth wire.

Embedded Temperature Detector. A thermo-junction or resistance thermometer embedded in a winding, etc., for indicating the tempera-

ture attained at an inaccessible point.

Emergency Release Push (in *Electric Lifts*). A push button, usually near the control-board of an electric lift, for allowing a car to be moved in emergency with one or more of the gates open.

Emergency Stop (in *Electric Lifts*). A switch in a lift car by which the electric supply can be cut off independently of all other control gear.

Emergency Switch. A switch in a convenient position for cutting off the supply of current in case of accident, either directly or through a tripping arrangement.

Emergency Wireless Apparatus. Wireless apparatus on board ship provided for emergency use when the main wireless apparatus is out of action.

E.M.F. The usual abbreviation for *Electromotive Force*.

Emission. See **THERMIONIC CURRENT**.

Emission: Grid, Secondary, and Total. See **GRID EMISSION**, **SECONDARY EMISSION**, etc.

Emissivity. A term used in photometry in comparing the light given out by different bodies per unit area at a given temperature.

Emissivity, Heat. See **HEAT EMISSIVITY**.

Emitron Camera. See **ICONOSCOPE**.

Empire Cloth. Cambrie impregnated with linseed oil by a special process; used for armature insulation, etc.

Enamel. See **INSULATING VARNISH**.

Enamel Insulated Wire. Wire covered with a coating of a special insulating moisture proof enamel; used principally for magnet coils and solenoids in arc lamps, control gear, etc.

Enamel Paint. See **INSULATING VARNISH**.

Enamel Rheostat. A form of *Rheostat* in which the resistances of wire, ribbon, etc., are embedded in porcelain enamel; used for *Shunt Regulators*, etc.

Enamelled Slate. Slate rendered suitable for switchboard purposes by a coating of hard black enamel to prevent absorption of moisture.

Enclosed Arc Lamp. An *Arc Lamp* in which the arc is surrounded by

a closely fitting globe which does not allow of the access of external air. The arc consequently burns in a hot atmosphere practically without oxygen with the result that a longer arc is used and the carbons burn away much slower than in the ordinary open arc. The efficiency is not so good but the light is of a colour nearer to daylight.

Enclosed Flame Arc Lamp. An *Enclosed Arc Lamp* employing *Flame Carbons*. Of rather different construction from an enclosed arc lamp for pure carbons as special means have to be provided to prevent fumes condensing in the enclosing globe. See *BLONDEL* and *JANDUS ARC LAMPS*.

Enclosed Fuse. A fuse in which the fuse wire is within a tube or other covering.

Enclosed Motors. See *FULLY ENCLOSED*, *SEMI-ENCLOSED*, etc.

Enclosed Self-Cooled Motor, etc. An enclosed motor, etc., with special means inherent in the machine for the circulation of air otherwise than by direct communication with the surrounding atmosphere.

Enclosed Starter. A starter in which all the contacts and resistances, etc., are in a closed case, usually of cast iron.

Enclosed Ventilated Motor, Switchgear, etc. An enclosed motor, switchgear, etc. with perforated covers over the apertures in the case. Cf. *FULLY ENCLOSED*, *SEMI-ENCLOSED*.

End Bell. A substantial metal cover placed over the end connections of a high speed armature to hold them against centrifugal force.

End Bracket. An open bearing support fixed to the frame of a machine and not to the bed plate.

End Cells. See *REGULATING CELLS*.

End Connections. That part of the armature coils which does not lie in the slots and joins together the active portions, whether consisting of separate strips, etc., connected up in place or simply of the bent portion of a former-wound continuous wire coil. See *BUTTERFLY CONNECTIONS*, *INVOLUTE CONNECTIONS*, *BARREL WINDING*, *FORMER-WOUND COILS*, etc.

End Connections, "V." See "V" *END CONNECTIONS*.

End Gap Static. A name given (in America) to the buzzing spark discharge that occurs at some of the gaps near the line end of a multigap arrester.

End Leakage. Magnetic leakage round the end of a stator or motor in dynamo-electric machinery.

End Plates. The flanges which hold together the stampings forming the core of a stator or rotor.

End Rings. See *COMMUTATOR END RINGS*.

End Ring, Static. See *STATIC END RING*.

End Shield. A casting bolted to the stator of an alternator, motor, etc., affording mechanical protection to the end connections, etc., preventing access to live parts and, in the case of enclosed machines, the entry of dust, etc., sometimes limited to cases where, especially in the smaller sizes of machines it carries the bearings; when not carrying bearings, they are sometimes called *Fenders* or *Protection Caps*.

Endodyne (Wireless) Reception. The arrangement of thermionic valve circuits for *Beat Reception* in which the source of the local oscillations of slightly different frequency is an actual part of the receiving apparatus; also called *Auto-Heterodyne* or *Autodyne* reception. Cf. *HETERODYNE RECEPTION*.

Endoscope. Apparatus for inserting a lamp within the body for the inspection of internal cavities.

Endosmose (Electrical). See *OSMOSE*.

End-Play Device. A device used on rotary converters, etc., to cause the rotor to move axially backwards and forwards over a short distance in the bearings to avoid the commutator wearing into grooves.

Energise. To put apparatus in action by connecting to the circuit.

Energy Amplification. The ratio of the energy taken from the output side of an amplifier to that applied to the input side.

Energy, Electrical. The capacity of an electric current to do *Work*. An expression also commonly used

for the supply from a generating station.

Energy Component. See ACTIVE CURRENT, VOLTAGE or VOLT-AMPERES.

Energy Losses. That portion of the energy input in electrical machinery or apparatus which is used up otherwise than in performing the useful work for which the apparatus, etc., was designed, such as in heating the windings, overcoming effects of hysteresis and eddy currents and mechanical friction.

Energy Meter. An instrument which registers or integrates the total amount of electrical energy which has passed in a circuit, i.e. a supply meter which takes account of the total watt-hours and not only the ampere-hours. See WATT-HOUR METER.

Engaged Test. The method of ascertaining whether a particular line in a telephone exchange system is engaged by touching the tip of the operator's calling plug upon the bush of the jack when a characteristic sound will be heard in the operator's receiver if the line is engaged.

Engineer, Chartered Electrical. See CHARTERED ELECTRICAL ENGINEER.

Engineer, Electrical. One competent to direct the application of electricity to industrial purposes on a large scale.

Engineering, Electrical. The application of electrical methods to engineering work, industrial processes, etc., on a large scale. Sometimes divided into *Heavy Current Engineering* relating to power, lighting and traction, etc., and *Light Current Engineering*, dealing mainly with *Electrical Communication*.

Engraving (Electric). A method of etching in which the plate forms the anode of an electrolytic cell.

Entering Edge (of a Brush). The edge of a brush with which any part of the commutator first makes contact.

Entz Booster. An automatic *Reversible Battery Booster* in which the excitation is controlled according

to the load conditions by means of a carbon rheostat.

Entz Petrol-Electric System. A system where the engine drives the rotating field system of a dynamo, the armature of which is mounted on the cardan shaft. When the slip is considerable, the current generated is used in a motor to reinforce the torque. At high speeds the dynamo simply acts as a magnetic clutch with small slip. Regulation is effected by variation of the relative field strengths of the two machines.

Epidiascope. A projector which can be used either as a *Reflectoscope* or for projecting ordinary lantern slides.

Epsilon (ϵ). Symbol for *Force* (electric).

Epstein Hysteresis Tester. An apparatus which measures combined hysteresis and eddy-current losses in a sample of sheet iron by the A.C. Wattmeter method. Piles of strips cut from the sheet to be tested are assembled to form a rectangular magnetic circuit, sometimes known as a *Magnetic Square*, every side of which carries a winding.

Equal Heterodyne. A heterodyne receiving circuit in which the auxiliary oscillations and those due to the received waves are approximately equal in amplitude.

Equaliser Ring. See EQUALISING RINGS.

Equaliser Switch. A switch which connects the armature end of the series field winding of one of a number of machines to the *Equalising Bar*.

Equalising Bar or Cable. An auxiliary *Bus Bar*, or *Cable*, by which all the series field windings of a group of compound wound generators are put in parallel for stability of regulation.

Equalising Connections. See EQUIPOTENTIAL CONNECTIONS.

Equalising Current. The interchange of current in an *Equalising Bar*, *Cable* or *Ring*, by which the required equalising action is effected.

Equalising Rings. Ring conductors in an armature to which equalising or *Equipotential Connections* are made.

Equator, Magnetic. See **MAGNETIC EQUATOR.**

Equipment, Electrical. The electrical apparatus, etc., required in addition to mechanical or other apparatus to achieve some object electrically.

Equipotential or Equalising Connections. Connections taken off from points in an armature winding, which should be at the same potential, and connected to *Equalising Rings* to allow of an interchange of current to ensure symmetry of the conditions in different parts of the winding.

Equipotential Lines or Surfaces. Lines or surfaces in an electric or magnetic field, at all points on which the electric or magnetic potential is constant; at right angles at any point to the lines of force intersecting them.

Equipotential Method. (Of simultaneous telephony and telegraphy.) The method of superposing telegraph or telephone circuits involving the use of a balanced *Phantom Circuit*.

Equisignal Radio-Beacon. A system of aerial navigation on a fixed route in which two modulated beams are projected from stations on each side of the route. When the aircraft is on its correct route the received signals are equal. In one system, the signals are so interlocked that a continuous sound is heard on the route, but different discontinuous sounds are heard on either side. In a further development a visual signal is used showing a single illuminated line when on the course and thick and thin parallel lines when off the course, the thick line corresponding to that side of the route to which the machine has diverted.

Equivalent: Electrochemical, Standard Cable and Transmission. See **ELECTROCHEMICAL EQUIVALENT, STANDARD CABLE EQUIVALENT, etc.**

Equivalent Disturbing Voltage (of a Power Circuit Adjacent to a Communication Circuit). The e.m.f. of a frequency of 800 cycles per sec. which has the same disturbing effect on the communication circuit as the operating voltage with its harmonics.

Equivalent Logarithmic Decrement and Equivalent Logarithmic Increment. The apparent value of the decrement or increment of oscillations or waves not diminishing or increasing in true geometrical progression as determined in the same way as the true logarithmic decrement or increment.

Equivalent Reactance. That value which a *Reactance* would require in order to have the same effect as a system of interlinked reactances complicated by magnetic leakage.

Equivalent Resistance. That value which a resistance would require to have in order to allow the same current to flow with the same applied e.m.f. as in a piece of apparatus in which other factors as well as resistance determine the current.

Equivalent Sine-Wave. A true sine-wave form having the same r.m.s. value and frequency as the actual wave form of an alternating current, voltage, etc.

Erg. The metric unit of energy, being that expended when a force of one dyne is exerted through one centimetre. Equal to 10^{-7} joule.

Erg-Meter. A name given to the earlier types of energy meter or watt-hour meter.

Error (of a Measuring Instrument). The difference between the indicator of the instrument and the true value of the quantity to be measured expressed in a percentage of the indication.

Error: Calibration, Cargo, Compass, Coupling, Electrostatic, Heeling, Lack of Symmetry, Night, Loop Tuning, Plain Tuning, Quadrantal, Semicircular, and Ship. See **CALIBRATION ERROR, CARGO ERROR, etc.**

Erythrometer. An instrument for measurement of that portion of the ultra-violet radiation given by a source of artificial sunlight which is effective in causing erythema (sunburn) of the skin. One method is by means of special photoelectric cells in conjunction with appropriate light filters. The range of wavelengths in question is from 2800 to 3200 Å.

E.S. Lamp Cap. See EDISON SCREW LAMP CAP.

Escals. A name given to the equivalent slot positions in each pole pitch in a multipolar winding.

Esterline Permeameter. An instrument for magnetic testing in which the sample bar forms part of a magnetic circuit containing an armature driven by a separate motor so that the c.m.f. produced is a measure of the flux in the circuit. The apparatus can be used for direct permeability measurements when suitably calibrated, or for plotting hysteresis curves by a step by step method, or with a standard bar in parallel magnetically with the test bar as a *Permeability Bridge* by varying the number of effective turns in the coil magnetising the sample until a balance is obtained where no c.m.f. is produced in the revolving armature.

Eta (η). Symbol for *efficiency*.

Ether. The hypothetical all-pervading medium by which light and all other electric waves are regarded as being propagated, and through which the forces between electrons are exerted.

Ether Drift. Relative movement between ether and matter. See MICHELSON-MORLEY EXPERIMENT.

Ether Waves. See WAVES (Electric).

Etheric Telegraphy and Telephony. See WIRELESS TELEGRAPHY and TELEPHONY.

Etheric Waves. See WAVES (Electric).

Etherophone. An electrical musical instrument, invented by Thoremin, resembling a multivalve wireless receiver in construction. The sounds are produced in a loud speaker by the beats due to the interaction of two oscillating circuits of fixed and variable frequencies respectively. The pitch is regulated by movement of the right hand of the performer in relation to an upright rod, thus making variations in the capacitance of the variable frequency circuit; while the volume is controlled by movement of the left hand relatively to a loop of wire in a part of the constant frequency circuit,

altering the amplitude of the oscillations by regulating the degree of resonance of that part of the circuit with the other part containing a piezo-electric resonator. A rectifying valve and one or more stages of low frequency amplification are used. (Also called *Thereminvox*.)

Ethonium. An electrical musical instrument on a similar principle to that of the *Etherophone*.

Eupatheostat. A form of thermostat for controlling room temperatures influenced by radiation and convection more nearly as is done by the human body than an ordinary thermostat controlled by air temperature alone. A blackened copper sphere communicates with a vessel in which a volatile liquid is heated. The amount of heat received by the sphere affects the vapour pressure within and this actuates a diaphragm controlled contact.

Eureka Wire. Wire made of an alloy of copper and nickel having a nearly constant temperature coefficient and not deteriorating to a great extent when kept at a high temperature.

Evolute Connections. A name sometimes inaccurately used for Involute connection.

Ewing Curve-Tracer, Hysteresis Tester, and Permeability Balance. See CURVE TRACER, HYSTERESIS TESTER, etc.

Ewing Permeability Bridge. A *Permeability Bridge* in which the lack of deflection of a needle (in a weak controlling field) between the pole pieces mounted on two yokes indicates equality in the flux through a standard bar and a bar of the same dimensions to be tested. The two bars are clamped parallel to each other by the yokes, and are magnetised in opposite directions by coils connected in series, the number of turns in which is varied until a balance is obtained, i.e. when no deflection of the needle is produced by reversing the current. The standard bar is calibrated by the *Double Bar and Yoke* method.

Ewing's Theory of Magnetisation. The explanation of the phenomena

- of magnetisation hysteresis, etc., by changes in the orientation and mutual grouping of independently magnetic constituents of atoms (probably consisting of the outer electron orbits). See also **MAGNETISATION**.
- Excess Pressure or Voltage.** See **OVER-VOLTAGE**.
- Excess Voltage Preventer.** A device employed in such cases as regenerative traction control for preventing the voltage produced rising above a limiting value.
- Exchange, Telephone.** See **TELEPHONE EXCHANGE**.
- Excitant.** A term sometimes used for the electrolyte in a primary cell.
- Excitation.** (1) The production in the iron core of a field magnet or other electromagnet of a magnetic flux by a current in a coil surrounding it or by the resultant effect of currents in several coils. (2) The current (or the *Ampsere Turns*) required in the windings of a field magnet or other electromagnet to produce the required strength of field; or in a.c. apparatus the component of the current required to provide the magnetising force. (3) The provision of oscillations in the aerial circuit of a wireless transmitting station, e.g. *Impulse Excitation*. (4) The production of an electrostatic charge in a body by friction, etc. (5) (In a mercury vapour rectifier), Maintenance of an auxiliary arc to prevent shutting down when the main arc is extinguished on no load.
- Excitation : Compound, Differential, Full, Impulse, Self, Separate, Series, Shock, and Shunt.** See **COMPOUND EXCITATION, DIFFERENTIAL EXCITATION, etc.**
- Excitation Loss.** The power required to produce the exciting current for a generator or motor.
- Exciter.** A direct current generator supplying current for excitation of one or more other machines.
- Exciter : Direct Coupled, Separate, and Undersaturated.** See **DIRECT COUPLED EXCITER, SEPARATE EXCITER, etc.**
- Exciter Field Rheostat.** A rheostat in the field circuit of the exciter of an alternator which controls the alternator voltage by varying the voltage of the exciter; used alone or in conjunction with a rheostat in the alternator field circuit.
- Exciter Set.** An *Exciter* complete with the motor, engine, or turbine which drives it.
- Exciting Circuit.** The circuit through which current is supplied to the field magnet windings of a machine and in which the field rheostat is included.
- Exciting Coil.** A coil on a field magnet or other electromagnet which carries the current producing the magnetic field.
- Exciting Current.** See **EXCITATION**.
- Exciting Winding.** See **FIELD WINDING**.
- Exide Accumulator.** The trade name of a lead accumulator for heavy discharge rates, with the active material in the form of pencils in which the ribs of the grid are embedded and with wood separators.
- Exosmose (Electrical).** See **OSMOSE**.
- Expander.** (1) An inert material, such as carbon or barium sulphate, added to the active material in accumulator plates to avoid shrinkage and to increase the porosity of the mixture. (2) See **COMPANDOR**.
- Expansion Volume.** See **VOLUME EXPANSION**.
- Expansion Switch or Circuit-Breaker.** A switch, etc., with contacts in high pressure steam or gas which is released by the movement of the electrodes so as to produce a sudden drop of temperature which extinguishes the arc.
- Expedance.** A term sometimes applied to the property of a circuit equivalent to negative impedance which has a current assisting effect due to conditions of resonance.
- Expedor Phase Advancer.** A *Phase Advancer* compensating the impedance drop in the induction motor in conjunction with which it works by generating a voltage proportional to the secondary current.
- Exploder, Magneto and Mine.** See **MAGNETO EXPLODER and MINE EXPLODER**.
- Exploring Brush.** A small additional brush, which can be shifted into any angular position between the main brushes, for investigation

by a voltmeter of the distribution of potential round the commutator.

Exploring Coil. A coil employed to measure a magnetic field, by the swing of a ballistic galvanometer connected to it, when the field or the position of the coil in it is suddenly reversed.

Explosion Pot Circuit-Breaker. A circuit-breaker in which a steel vessel surrounds the arcing contacts with the object of accelerating the break by confinement of the explosion, and to relieve the pressure on the oil tank. See also **TURBULATOR**.

Explosion Proof. See **FLAME PROOF**.

Exponential Horn. A *Horn* for a Loud Speaker, the diameter of which varies along the length according to an exponential law. Cf. **LOGARITHMIC HORN**.

Exposed Wiring. See **SURFACE WIRING**.

Expulsion Fuses. Enclosed fuses in which the arc is extinguished by the blowing of the volatilised metal, etc., out through a vent.

Expulsion Tube. An open-ended tube with electrodes at both ends connected in series with a gap in parallel with a string of h.t. line insulators to act as a lightning arrester, the arc in the tube being broken by the rapid expulsion of the gases liberated from the special material with which the tube is lined.

Extension Bell. An additional bell arranged to ring at the same time as the ordinary telephone or other bell.

Extension Lines (Telephone). Lines radiating over a telephone installation from a private switchboard to the various extension instruments.

Extensive Reflectors. Reflectors designed to diffuse the light over a considerable area of uniform illumination. Cf. **INTENSIVE REFLECTORS**.

Extension Set (Telephone). An additional *Subscriber's Set* either connected permanently in bridge with the main instrument of a telephone subscriber's installation or connected when required.

Extensometer (Electrical). An instrument in which change of dimensions

of the specimen under test produce a change in the capacitance of two capacitors, and the effect of which on the circuit to which they are connected is amplified and recorded by an oscillograph.

External Armature Alternator. An alternator in which the stationary armature surrounds the revolving field. Cf. **REVOLVING FIELD ALTERNATOR**.

External Characteristic. A curve showing relations between the terminal voltage and the current in the external circuit given by a generator. Cf. **INTERNAL CHARACTERISTIC**.

External Circuit. The portion of the circuit to which current is supplied outside the main terminals of the battery, generator, or station producing the supply.

External Conductor. The conductor in a concentric cable which surrounds the other, or others.

External Resistance. The resistance of the *External Circuit*.

External Self-Inductance. An expression used in connection with cables and other conductors for the inductance due to the field outside the conductor. Cf. **INTERNAL SELF-INDUCTANCE**.

Extra Current. An old-fashioned name for the current rushes due to self induction.

Extra High Pressure. The official Board of Trade description of a pressure above 3,000 volts between any two conductors (of a system), or between one conductor and earth.

Extra High Tension (E.H.T.). An expression usually understood to be synonymous with *Extra High Pressure*.

Eye (Electric). A popular expression for a photoelectric or other light sensitive cell used in connection with relays and to control any apparatus according to the light falling upon it.

Eye-Ball Indicator. A form of visual signal in the older telephone exchanges in which distinguishing marks are brought into view through an aperture by the partial rotation of a ball.

F]

F. Abbreviation for *Farad*: symbol for *Magnetomotive Force*.

f. Symbol for *Frequency*.

Face Plate Controller and Face Plate Starter. The most widely used type of a controller, or *Motor Starter*, in which a single contact lever moves over a number of fixed contacts in the front of an insulating plate.

Facing, Steel. See *STEEL FACING*.

Facsimile Telegraph. See *PHOTO-TELEGRAPHY*.

Factor: Absorption, Amplitude, Attenuation, Breakdown, Copper, Crest, Damping, Decay, Distribution, Duty Cycle, Form, Fusing, Impedance, Irregularity, Klirr, Luminosity, Non-Linear Distortion, Operating, Peak, Power, Radiation, Reactive, Reflection, Ripple, Saturation, Space, Spherical Reduction, Spread, Telephone Interference, Utilisation, Variation, and Winding. See *ABSORPTION FACTOR*, *AMPLITUDE FACTOR*, etc.

Factor of Merit. An expression sometimes used for the *Sensitivity* which a given galvanometer would have if its resistance were one ohm and its time of swing, ten seconds.

Factory Fitting. A robust type electric light fitting in which the lamp is enclosed in a strong glass cover.

Fade Unit. A potentiometer arrangement placed in the amplifier circuit of a broadcasting microphone by which the strength of the modulation can be continuously varied down to zero to "fade out." See also *MIXING UNIT*.

Fading. Temporary weakening of signals irrespective of the adjustment of the transmitter or receiver, possibly due to interference of waves which have reached the same point by different routes, e.g. partly by refraction by the irregular and constantly changing electronic

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clouds of the *Ionosphere*, or solely to changes in the strength of the waves coming from above.

Fading, Differential, Intensity, Phase and Selective. See *DIFFERENTIAL FADING*, *FADING INTENSITY*, etc.

Fall of Potential. See *DROOP* or *POTENTIAL*.

Fall of Potential Test. A fault localising test in which the potential drop along a known length of the cable is compared with that of the length up to the fault.

Falling Characteristic. A *Characteristic Curve* representing the state of affairs when the voltage given by a generator falls with increase of current.

False Zero Test. A test on the bridge or other principle in which the galvanometer is deflected by some constant or slowly altering extraneous current and the balance is made so that this deflection is not altered by the depression of the testing keys.

Fan (Electric). An electrically driven fan of the propeller, centrifugal or other type to produce a current of air for ventilation, etc.

Fan Aerial. An *Aerial* in which the component wires are spread out fanwise.

Fan-Cooled Motor, etc. A fully enclosed motor, etc., cooled by forced ventilation produced by a fan driven by the machine itself.

Fan Ventilated Motor. See *FAN-COOLED MOTOR*.

Farad (F.). The unit of *Capacitance* corresponding to the *Practical Electrical Units*; i.e. that capacitance which is charged to a pressure of one volt by one coulomb, equal to 10^{-9} absolute C.G.S. electromagnetic units. As this is inconveniently large for ordinary purposes, the *Microfarad* ($\mu F.$), one millionth of a farad, is commonly used, although in many formulae capacitance is expressed in farads

for making calculations. (Named after Michael Faraday, 1791-1867.)

Faradaic. See FARADIC.

Faraday. A unit of quantity of electricity sometimes used in electro-chemistry, being the quantity required to deposit a "gramme equivalent" of the substance, and equal to 96,500 coulombs. Symbol: *F*.

Faraday Cage. An earthed wire cage surrounding apparatus which is to be protected from outside electrostatic influence used on a large scale by Faraday to demonstrate that a charge exists only on the outside of a conductor, as a charge imparted to the cage cannot be detected by an operator within.

Faraday Cell. A *Light-Relay* dependent upon the *Faraday Effect*.

Faraday Effect. The rotation of the plane of polarisation of light or electric waves passing through a piece of a particular kind of heavy glass and certain other materials, when subjected to a strong magnetic field.

Faraday Tubes. Tubes of electrostatic force. Unit tube starts from unit positive charge and ends on unit negative charge. Thus one tube (not 4 π tubes) leaves unit charge. Cf. MAXWELL TUBES.

Faraday's Dark Space. The dark space in the discharge in a moderately exhausted *Vacuum Tube* between the *Negative Glow* and the *Positive Column* (or the *Striae* into which it breaks up); varying in its position along the tube according to the degree of exhaustion. Cf. CROOKES' DARK SPACE.

Faraday's Disc. A disc in which currents are induced by rotation in a magnetic field or *vice versa*; used in experiments which confirmed and explained *Arago's Rotations* and laid the foundation of the principle of the dynamo.

Faraday's Heavy Glass. See FARADAY EFFECT.

Faraday's "Ice-Pail" Experiment. Experiment made by lowering a charged ball into a metallic pail connected to an electroscope to show that charges reside on the outside surfaces of conductors.

Faraday's Laws. (1) Of *Electrolysis*.

(a) The quantity of a substance deposited in a given time is proportional to the current. (b) The quantities of different substances deposited by the same current in the same time are proportional to their electro-chemical equivalents. (2) Of *Induction*: The e.m.f. induced in a circuit is proportional to the rate of change in the lines of force linking the circuit.

Faraday's Ring. The ring of iron provided with two windings by which Faraday discovered the principle of electromagnetic induction on 29th August, 1831.

Faradic Currents. A term used in electromedical work to signify currents obtained from an *Induction Coil*.

Faradisation or Faradism. The application of currents from an induction coil for remedial purposes.

Faradise. To stimulate with FARADIC CURRENTS.

Faradiser. An appliance for effecting curative treatment by the application of *Faradic Currents*.

Fathometer. A direct reading apparatus for *Echo Sounding*, depending upon a stroboscopic arrangement employing a neon lamp.

Fatigue : Dielectric and Magnetic. See DIELECTRIC FATIGUE and MAGNETIC FATIGUE.

Fault. An accidental discontinuity in a circuit, or a point of defective insulation, where there is a dead or partial earth, or short circuit or leakage to earth or to the other pole in a circuit.

Fault : Intermittent, Polarisation of and Resultant. See INTERMITTENT FAULT, POLARISATION OF FAULT, etc.

Fault Current. The current through a fault, whether of small value classed as *Leakage* or amounting to that through a dead earth or short circuit.

Fault Localisation. See LOCALISATION OF FAULTS.

Fault Resistance. A term sometimes used for the insulation resistance of one main of a system when all lamps, etc., are removed for testing.

Fault Signalling Network. A distributing system in which an arrangement of pilot wires is employed to actuate signals in the station when, owing to a fault on a cable, they become connected to a main conductor.

Faure Accumulator Cell. Lead accumulator cells in which the active material is in the form of paste held in the interstices of a grid. Cf. *PLANTÉ* type of cell.

Faure Plate. See *PASTED PLATE*.

Feed Back (in Wireless Telegraphy, etc.). See *RETROACTION*.

Feed Current (in a Thermionic Valve). The direct current component of the anode current.

Feed Mechanism (of an Arc Lamp). The mechanism which causes the carbons to move gradually towards the arc at the required speed to keep the arc length constant as the carbons burn away; actuated electromagnetically by the drop of the current below its normal value or the increase of the voltage across the arc above its normal value as the arc increases in length.

Feeder. (1) A cable or other conductor used to supply electrical energy from a station or substation to a point from which it is distributed, i.e. to "feed" the network at an appropriate point. (2) In wireless telegraphy, etc., A conductor connecting an aerial with the transmitting or receiving apparatus.

Feeder: Dead-Ended, Duplicate, Incoming, Independent, Interconnecting, Multiple, Negative, Outgoing, Parallel, Positive, Radial, Return, Single, Trunk, and Unit. See *DEAD ENDED FEEDER*, *DUPLICATE FEEDER*, etc.

Feeder Box. A box containing the necessary switches, links, fuses, etc., for connecting a *Feeder* to a distributing network, traction line, etc.

Feeder Bus-Bars. Bus-bars in a generating station, etc., to which the outgoing feeders are connected through switches.

Feeder Ear. A special type of trolley wire *Ear* to which a feeder is connected.

Feeder Panel. A panel on a switch-board provided with the switch-

gear and instruments controlling a group of *Feeder* circuits or a single feeder.

Feeder Pillar. A *Feeder Box* in the shape of a pillar.

Feeder Protection. A system for ensuring the cutting out of a feeder circuit on the occurrence of a fault thereon. See *PROTECTIVE SYSTEM*.

Feeder Switch. A switch for connecting a *Feeder* to the *Bus-Bars* in a generating station, substation, etc.

Feeder Voltmeter. A voltmeter at a generating station showing the voltage across a feeder. See *PILOT VOLTMETER*.

Feeding Point. A point on a network, traction line, etc., to which a *Feeder* is connected.

Feeler Switch. A switch forming part of the equipment of one form of automatic substation equipment which is used after a circuit-breaker has come out to close a testing circuit automatically, which is so interlocked that if the short circuit has not been cleared the circuit-breaker is prevented from being automatically replaced.

Feet Switch. See *TROPICAL SWITCH*.

Fender. An *End Shield* not carrying a bearing.

Ferranti Effect. The rise of voltage which takes place when an alternator is switched on to an unloaded feeder having considerable capacitance, owing to the resonance produced.

Ferranti-Hawkins Protective System. A cable protective system employing core-balance transformers at both ends of the cable with their secondaries in series through pilot wires and tripping coils.

Ferranti Meter. See *MERCURY MOTOR METER*.

Ferranti Rectifier. A rectifier in which a synchronously driven commutator reverses the negative half of each wave; employed in conjunction with constant-current transformers for arc lighting. Cf. *ELECTROLYTIC* and *MERCURY VAPOR RECTIFIERS*, etc.

Ferraris Instruments. Measuring Instruments (ammeters, voltmeters,

wattmeters, etc.), in which a metal drum is deflected against a controlling spring by a torque produced by a rotating field due, in polyphase systems, to a natural difference of phase, or, in single phase systems, to an artificially "split" phase. See also INDUCTION INSTRUMENTS, SHIELDED POLE, etc.

Ferraris Motor. One of the original types of two-phase induction motor.

Ferrocort. A material composed chiefly of iron dust spread on paper sheets with adhesive material, such sheets being piled up compressed and consolidated by heat into a solid mass. Used for cores of tuning coils, etc., in wireless receivers to enable very compact coils to give increased sensitivity and selectivity. Cf. DUST CORE and NICORE.

Ferromagnetic. A substance is said to be "ferromagnetic" when its *Permeability* is very considerably above that of air, and varies at different values of the *Flux Density*. The principal ferromagnetic substances are iron (and certain steels), nickel and cobalt, i.e. when it shows the very marked magnetic effects exhibited by iron, etc.

Ferromagnetism. The magnetic property shown by *ferromagnetic* substances.

Ferrometer. A name sometimes given to instruments for carrying out permeability and hysteresis tests of iron and steel.

Ferro-Resonance. The peculiar condition of *Resonance* which can be produced in armoured cables when the iron sheathing causes a variation of the inductance according to the current and has the effect of adapting it to the value required for resonance over a considerable range or frequencies.

Ferry. A copper-nickel alloy used for resistances, similar to *Constantan*.

Féry Radiation Pyrometer. See RADIATION PYROMETER.

Fessenden System of Wireless Telegraphy. An early system distinguished chiefly by a variable wave method of sending, and the use in its earlier forms of the *Barrettter* and later of an *Electrolytic Detector*.

Festoon Lamp. A tubular straight filament incandescent lamp, with terminals at the ends. Originally so called on account of this form being suitable for hanging in series in festoons.

Festoon Lighting. Lighting by incandescent lamps arranged at regular intervals in special holders, along a flexible cable.

Fidelity (as applied to Sound Reproduction). The degree of approach to equality of amplification of input at all audio-frequencies within the range required, on which the quality of the acoustic output depends.

Field. (Electric or Magnetic). A term used to indicate a region where magnetic or electrostatic forces are exerted, or in dynamo-electric machinery the system of magnets producing the working magnetic flux.

Field: Commutating, Compensating, Cross, Cross Connection, Distortion of, Electrostatic, Hemitropic, Magnetic, Main, Residual, Reversing, Rotary, Rotating, Series, Shunt, and Stray. See COMMUTATING FIELD, COMPENSATING FIELD, etc.

Field Ampere-Turns. The ampere-turns required to produce a given field strength in a machine.

Field Bobbin. See BOBBIN.

Field Breaking Switch and Resistor. See FIELD DISCHARGE SWITCH and RESISTOR.

Field Coil. A self-contained coil, usually fitting over the limb of one pole and forming part of a complete *Field Winding*.

Field Control (in Electric Traction). Variation of the speed of the motors by shunting or cutting out portions of the field windings.

Field Copper. An expression used in dynamo design for the whole amount of copper in the field winding of a machine.

Field Current. See EXCITATION.

Field Discharge Resistor. A high non-inductive resistance placed across the terminals of a dynamo or motor field winding when the exciting circuit is broken to receive the current rush due to its high inductance and to prevent a

- harmful rise in potential. (Also called *Buffer Resistance*.)
- Field Discharge Switch.** A switch arranged to put a *Field Discharge Resistance* in parallel with a field winding before the exciting circuit is broken.
- Field Diverter Rheostat.** See DIVER-TER TYPE FIELD RHEOSTAT.
- Field Form.** A curve showing the distribution of the flux round the air-gap of a machine.
- Field Intensity** (Electric). A term used in electrostatics for the equivalent of *Potential Gradient*. (Also called *Electromotive Intensity*.)
- Field Magnet.** The part of a dynamo electric machine consisting of a core and a winding, or of a *Permanent Magnet*, which provides the magnetic field in which the armature works. (Sometimes colloquially spoken of as *Fields*.)
- Field Plates.** The separate set of conductors used in some forms of *Influence Machine* to induce charges in the Carriers.
- Field Regulator or Rheostat.** A variable resistance placed in the field circuit of a generator for regulating the voltage, or of a motor for regulating the speed, by variation of the strength of the field.
- Field Rheostat: Balancer, Diverter Type, Potentiometer Type, and Reversible Potentiometer Type.** See BALANCER FIELD RHEOSTAT, DIVERTER TYPE RHEOSTAT, etc.
- Field Spider.** A structure with spokes carrying the ring of poles in a revolving field machine.
- Field Splitting Switch.** A switch for subdividing the field winding of a rotary converter for starting purposes.
- Field Spool.** The flanged tube or bobbin on which a field coil is wound. Sometimes used incorrectly for the coil itself whether wound on a support of this kind or not.
- Field Strength.** (1) See FORCE (Electric). (2) Used by wireless engineers to signify the alternating field produced by the unmodulated carrier wave of a transmitter at any particular distant point measured by millivolts induced in an aerial per metre of effective height. Cf. SIGNAL STRENGTH.
- Field Suppressor.** An automatic switch connected to protective gear which reduces the field of a generator on the occurrence of fault conditions.
- Field Winding.** The whole of the winding on the field magnet system of a machine. See DISTRIBUTED and CONCENTRATED WINDING, etc.
- Fields.** See FIELD MAGNETS.
- Figure Eight Wire.** Wire for *Overhead Contact Lines* made with a section resembling the figure eight with the upper half smaller than the lower, so as to provide grooves to be clipped mechanically by the ears. See also GROOVED WIRE.
- Figure of Loss.** An expression used in transformer testing, etc., for a number proportional to the energy loss per pound of material.
- Figure of Merit.** An old-fashioned term indicating the *Sensitivity* of a galvanometer or other piece of apparatus; defined variously as the current required to deflect a galvanometer one scale division, or as its reciprocal. In relays and other telegraph apparatus, the minimum current that will actuate the apparatus.
- Figures: Dust, Lichtenberg, and Magnetic.** See DUST FIGURES, LICHTENBERG FIGURES, etc.
- Filament.** The fine high resistance conductor, such as that which glows to incandescence in an electric incandescent lamp, valve tube, etc., or is used in a thermionic valve either to form the electron emitting hot cathode or to heat another body which actually provides the emission. Originally applied only to those made by a process other than wire-drawing.
- Filament: Carbon, Castellated, Cathode, Coiled Coil, Colloidal, Disintegration of, Drawn Wire, Flashing of, Graphitised, Helion, Horse-shoe, Looped, Metal, Metallised, Metallic, Oxide-coated, Pasted, Ring, Squirted, Straight-up-and-down, Thoriated, Tungsten, and Wreath.** See CARBON FILAMENT, CASTELLATED FILAMENT, etc.
- Filament Efficiency** (of a Thermionic Valve). The ratio of the *Total Emission* in milliamperes to the

power used in heating the filament in watts.

Filament Electrometer. An electrometer in which the moving part consists of a filament, the deflection of which is observed through a microscope.

Filament-Heating Transformer. A small transformer supplying current for heating the filaments of large "X" Ray (Coolidge) tubes, Thermionic Valves, etc.

Filament Lamp. An expression preferred to "incandescent lamp" for a lamp in which a filament or wire is raised to incandescence by an electric current.

Filament Resistance. (1) The resistance of a lamp or other filament. (2) See FILAMENT RHEOSTAT.

Filament Rheostat. A variable resistance in series with the filament of a thermionic valve for regulating purposes.

Filings Coherer. A *Coherer* in the form of a tube of filings with suitable electrodes.

Filonator. A trade name for a form of *Darimont Cell*, suitable for low tension batteries of wireless receiving sets.

Filter (Electric). See FREQUENCY FILTER.

Filter: Band, Band Pass, Band Rejection, Frequency, Harmonic, Heterodyne, High Pass, Low Pass, and Scratch. See BAND FILTER, BAND PASS FILTER, etc.

Final Limit Switch (in Electric Lifts). A limit switch designed to stop the car if it should overrun the *Terminal Limit Switch*.

Filtration (or "X" Rays). Absorption of the rays of longer wavelengths by a suitable medium.

Filter Circuit. See WAVE FILTER.

Final Selector (in Automatic Telephony). A *Selector* responding to the current impulses, representing the last two figures of the call dialed, which makes connection between a *Hundreds Selector* and the required subscriber's line.

Finder, Digit and Line. See DIGIT FINDER and LINE FINDER.

Finding (in Automatic Telephony). The automatic action of a selector arranged to establish connection with a calling line. Cf. HUNTING.

Finger Type Contacts. Controller contacts of a form resembling fingers, each held up by a spring action as opposed to laminated or *Brush Contacts*.

Fingers, Contact. See CONTACT FINGERS.

Finsen Lamp. A form of Arc Lamp particularly rich in ultra-violet rays, used for curative purposes in skin diseases, etc.

Fire (Electric). This name is given to various designs of electric room heater both of the true *Radiator* and *Radio-convector* types, but is usually confined to those in which a visible glow is produced; sometimes made to resemble a coal fire in appearance and provided with an artificial flickering effect to heighten the resemblance.

Fire Alarm. An apparatus for ringing an alarm bell, actuating indicators, etc., electrically, on the outbreak of a fire, either automatically or by hand. See CLOSED CIRCUIT SYSTEM and OPEN CIRCUIT SYSTEM.

Fire Bars (Electric). A name given to the heating elements in some forms of electric radiator or *Electric Fire*.

Fireproof Covering. Covering to wires, cables, etc., which is entirely incombustible. Cf. FIRE-RESISTING.

Fire-Resisting Covering. Covering to wires, cables, etc., which consists of a non-combustible outer layer protecting a layer of insulation which is not necessarily itself incombustible. Cf. FIREPROOF.

Firing Key. A key used to fire a gun or a charge of explosive or several guns or charges simultaneously by closing a circuit containing electric fuses.

First Party Release. A system whereby the switches, etc., making a connection in a telephone exchange are released for clearing the line automatically on the replacement of either receiver. Cf. CALLING PARTY RELEASE.

First Selector (in Automatic Telephony). A *Selector* responding to the current impulses representing the Exchange Code in the call dialed, passed on to it by the *Director*, the function of which is

to secure connection with an appropriate *Function Selector*.

Fish (Electrical). Aquatic animals possessing electrical organs which can give electric shocks at will to their enemies. See EEL, RAY, SILURUS, TRICINUS, and TETRADON.

Fish Wire. A wire introduced into a conduit pipe, etc., during construction to be used afterwards to draw in the conductors.

Fittings. (Electric Light). The plain or ornamental supports carrying lamps for electric incandescent lighting. Executed in various styles (e.g. Louis XV fittings) and of various forms (e.g. *Brackets, Pendants, Standards, Table Lamps*, etc.).

Fittings: Bulkhead, Candle, Conduit, Factory, Indirect, Inspection, Mill, Oyster, Semi-Indirect, Split Conduit, Watertight, Weather-Proof. See BULKHEAD FITTINGS, CANDLE FITTINGS, etc.

Five Electrode Valve. A *Thermionic Valve* with five electrodes, e.g. with a *Filament*, a *Plate*, and three *Grids*. See PENTODE.

Five Needle (Telegraph) System. An early telegraph receiver (of Cooke and Wheatstone), in which the simultaneous movement of two out of five vertical needles in the receiving instrument to the right or left indicated the letter sent. Each needle was actuated by a separate galvanometer, and five line wires were required. Cf. DOUBLE NEEDLE SYSTEM and SINGLE NEEDLE SYSTEM.

Five-Point Jack. A *Jack* having two pairs of contact springs as well as a connection to the metallic bush through which the plug is inserted.

Five-Wire System. A rarely used system of distribution extending principle of the *Three-Wire System* and employing one neutral, two intermediate and two outer conductors.

Fix, Wireless. See WIRELESS FIX.

Fixation of Nitrogen. The formation from the nitrogen in the air, of compounds useful in agriculture and industry, including (1) direct oxidation of the nitrogen for the manufacture of nitric acid, etc.; a

special electric arc furnace (see ARC PROCESS), and (2) the formation by partly electrical methods of other compounds, as in the *Cyanamide* and *Synthetic Ammonia Processes*.

Fixed Handle Circuit-Breaker. A *Circuit-Breaker* with a rigid connection at all times between the handle and the moving contacts. Cf. FREE HANDLE.

Fixed Resistance or Fixed Resistor. A resistance, the value of which cannot be varied by adjustment.

Fixed Time Lag. See DEFINITE TIME LAG.

Fixtures. See FITTINGS.

Flame Arc. An Arc between carbons containing metallic salts, etc., which impart a considerable degree of luminosity to the vapour in the arc itself so that a large proportion of the light comes therefrom. The colour of the light depends on the material introduced into the carbons.

Flame Arc Lamp. A form of *Arc Lamp* for producing a *Flame Arc* from special carbons, in the case of the *Open Flame Arc Lamp*, usually employing converging downwardly-pointing carbons and with the position of the arc controlled by a blow-out magnet. See also ENCLOSED FLAME ARC LAMP.

Flame Carbons. Chemically prepared *Carbons* for *Flame Arc Lamps*. See IMPREGNATED CARBONS and FLAME CORED CARBONS.

Flame Cored Carbons. *Cored Carbons* in which the core contains chemical substances for the purpose of imparting luminosity of a distinctive colour to the arc.

Flame Lamp. An incandescent lamp in a crinkled pointed frosted bulb made in imitation of the flame of a torch, candle, etc.

Flame Microphone. An experimental form of telephone transmitter in which the modulations of the current are controlled by the change of resistance between two electrodes in a flame owing to the action of the sound waves impinging on the flame.

Flame-Proof Motor, Switchgear, etc. Machines and apparatus such as those intended for use in collieries

are said to be "flame-proof" or "flame-tight" when, although not airtight, they are enclosed in a manner that precludes the possibility of flame, caused by a local ignition of gas inside the case being communicated to an explosive mixture outside. This is done by taking advantage of the cooling effect either of wire gauze or of narrow channels between extensive flanges or plates. See FLANGE and PLATE PROTECTION.

Flaming-Arc, Arc Lamp, Carbons, etc. See FLAME ARC, etc.

Flange Protection. The rendering of apparatus *Flame Proof* by providing all joints in the cases with very large flanges without packing. See FLAME PROOF.

Flank Dispersion. Leakage of magnetic flux round those parts of the windings of a machine, which are not embedded in the slots.

Flash, Ribbon. See RIBBON FLASH.

Flash Arc. A sudden discharge between the electrodes of a large thermionic valve due to failure of the insulation on account of deterioration of the vacuum, causing the complete breakdown of the tube. Sometimes called *Rocky Point Effect*.

Flash Barrier. A screen of fireproof non-conducting material between brushes of opposite polarity in a rotary converter to prevent *Flashing Over*.

Flash Guard. See ARC SHIELD.

Flash Lamp. (1) A self-contained pocket or other portable lamp, complete with battery, or other lamp suitable for occasional flashes of light of short duration. (2) A small incandescent lamp for use in such apparatus. (3) A lamp producing a flash of light for photographic purposes by the explosion by electrical means of a magnesium mixture within a glass bulb to avoid the smoke and fire risk of the earlier forms of magnesium apparatus.

Flash Light. See FLASH LAMP.

Flash Magnetisation. Magnetisation by a current impulse of so short a duration that it does not penetrate below a shallow layer of the

material. Sometimes used in MAGNETIC CRACK DETECTORS.

Flash Suppressor. An arrangement for preventing *Flash-overs* on generator commutators. One form consists of a very high-speed trip switch, which short-circuits slip-rings connected to certain points on the armature winding, reducing the voltage to zero, before the flash over has had time to take place.

Flash Test. A test of insulation by the momentary application of a voltage very much higher than the working voltage. Cf. FLASH-OVER TEST.

Flash Welding. A system of electric welding in which an arc is first struck between the pieces to be welded and, after being so heated, they are brought together and the weld completed by pressure, after the current has been cut off.

Flasher. An apparatus for intermittently lighting and extinguishing lamps, or groups of lamps, on an electric sign, etc., actuated mechanically or thermally.

Flasher, Thermal. See THERMAL FLASHER.

Flashing (of Filaments). Heating a carbon *Filament* in an atmosphere of hydrocarbons whereby a coating of carbon is deposited thereon, which is thicker where the original filament was thinner and therefore hotter, making the filament more homogeneous and adding greatly to its durability. (Also called *Treating*.)

Flashing, Side. See SIDE FLASHING.

Flashing Over. Accidental formation of an arc, e.g. over the surface of a commutator from brush to brush, usually started by abnormal voltage surges and facilitated by dirt or breakdown of insulation between the segments, or over the surface of an insulator under a high voltage test or otherwise.

Flash-over. See FLASHING OVER.

Flash-over Test. See SPARK-OVER TEST.

Flat. A point on a commutator where a bar or bars are lower than the rest due to unequal wear or other cause.

Flat Aerial. A special form of directive aerial used in the *Beam System* of wireless telegraphy; composed of a grid arrangement of wires, with a similar unexcited grid behind it acting as a reflector and giving a concentrated "beam" in one direction only.

Flat Compounding. The provision of *Compound Excitation* with the proportion of the series and the shunt excitation so adjusted that the terminal voltage is constant at all loads. Cf. *OVER-COMPOUNDING*.

Flat Ring Armature. See *DISCOIDAL ARMATURE*.

Flat Topped Wave Form. A wave form curve of e.m.f. current, etc., the maxima of which are less pointed than are those of a true sine-curve.

Flat Tuning. The existence of a considerable range of adjustment of the tuning apparatus of a wireless receiver over which response to a particular wave can be obtained, often due to excessive self-capacitance or resistance in the receiving inductance. Cf. *SHARP TUNING*.

Flat Twin Cable. Cable containing two separately insulated conductors side by side but not twisted together, suitably covered or sheathed, used extensively in interior wiring systems.

"F" Layer. See *APPLETON LAYER*.

Fleming's Rule. If the thumb and first and second fingers be stretched out at right angles to one another, and the first finger represents the direction of the magnetic lines of force, the thumb the direction of motion, and the second finger the direction of the current, the right hand will give the correct relations between these directions for a conductor in the armature of a generator, and the left hand for a conductor in the armature of a motor. (Sometimes called the *Right- and Left-Hand Rules*.)

Flewelling Circuit. A system of wireless reception of extreme sensibility in which one valve is used at the same time as a detector, amplifier,

and local oscillator for *Super-reaction*, with or without further amplification stages.

Flexible or "**Flex.**" The colloquial designation of *Twin Flexible Cord* for electric light purposes, etc.

Flexible Cable. Single or multicore cable of any description in which the core is made of a sufficient number of fine strands to render it flexible. See *TWIN FLEXIBLE CABLE*.

Flexible Cord. Flexible cable of small section.

Flexible Suspension. A method of suspending an overhead contact line in which it is not attached to rigid supports, but is slung on wires, etc., which allow a certain amount of freedom of vertical and lateral movement. Cf. *RIGID SUSPENSION* and *SEMI-RIGID SUSPENSION*.

Flexible Wiring. Interior wiring by flexible cables.

Flicker Effect (in a Thermionic Valve). A slight irregularity in the plate current probably mainly due to random emission of positive ions by the cathode.

Flicker Photometer. A photometer in which illumination from the two sources to be compared is observed by the eye alternately in rapid succession. When the two respective illuminations are equal the flickering effect disappears.

Flinders Bar. A bar of soft iron placed in the correct position in a ship's compass due to variation of the vertical component of the Earth's magnetism in different parts of the world. See also *SEMI-CIRCULAR*, *QUADRANTAL*, and *HEELING ERRORS*.

Float. The row of incandescent lamps generally including some of different colours on separate circuits, in front of a theatre stage, popularly known as the footlights.

Float Switch. A switch actuated by a float to control a pump motor.

Floating Battery. A storage battery connected permanently in parallel with the circuit, to assist in equalising the load by discharging at times of heavy load and being charged at times of light load;

and to act as a stand-by; often controlled by an *Automatic Reversible Booster*.

Floating Carrier System (of Wireless Transmission). A method of transmission in which an approximately constant percentage of modulation is employed while the amplitude of the carrier wave is varied from the maximum down to a low value.

Floating Rings. Contact rings in a drum type controller which have a certain amount of freedom of rotation with respect to the drum so that some angular movement of the drum in the reverse direction is required before they move with it.

Flood Lamp or Flood Light. See FLOOD LIGHTING.

Flood Lighting. Lighting by means of "flood lights" or lamps provided with reflectors directing the light in one direction like a *Projector*, but not in such a narrow beam, for producing powerful illumination over a considerable area.

Floor Contact (in Electric Lifts). A contact interlocked with the control gear, actuated by a passenger stepping into the car.

Floor Insulator. A tube of porcelain or other insulating material for insulating conductors where they pass through a floor.

Floor Polisher (Electric). A self-contained apparatus which can be moved about over the surface of a floor by a long handle, containing a revolving or reciprocating brush driven by an electric motor.

Floor Switch (in Electric Lifts). See LANDING SWITCH.

Fluctuation Voltage. The minute voltage changes in a thermionic valve due to such causes as SHOT EFFECT, FLICKER EFFECT, and THERMAL AGITATION.

Fluid, Electric. In the older theories, electricity was regarded as a fluid, and a positive or negative charge was regarded by some as the presence of one or other of two kinds of "electric fluid" and by others as an excess or deficiency of one kind. See ONE FLUID and TWO FLUID THEORIES.

Fluorescence. The emission, by a

body, of energy absorbed from radiation at one wave length, at a different wave length, e.g. of visible light rays from ultraviolet or from "X" rays.

Fluorescent Screen. A surface coated with a substance such as barium platinoeyanide, which fluoresces with a bright green light when such radiations as "X" rays fall upon it; used to render visible the shadows cast by these rays, such as those of bullets or other metal objects embedded in the body.

Fluorescent "X" Rays. See CHARACTERISTIC RADIATION.

Fluoroscopic Screen. See FLUORESCENT SCREEN.

Fluoroscopes. The use of a fluorescent screen acted on by "X" Rays.

Flush Switches, etc. Switches, etc., recessed into the wall so that the flat cover-plate is flush with the surface.

Fluted Carbons. Carbons with grooved sides for heavy current arc lamps for lighthouses, etc.

Flux. The term "flux" is used for the total amount of anything which may be conceived of as flowing from a source or through some channel or circuit; used in particular of *Electric* or *Magnetic Flux*, and *Luminous Flux*.

Flux: Balancing, Cross, Electrostatic, Leakage, Lower Hemispherical, Luminous, Magnetic, Pulsating, Remanant, Resultant, Total, Upper Hemispherical, and Working. See BALANCING FLUX, CROSS FLUX, etc.

Flux Coefficient. A term used in dynamo design for the ratio of the actual value of the flux per half pole to the value that it would have if uniform at its maximum density between the pole axis and the neutral line. Cf. FRINGING COEFFICIENT.

Flux Density. (1) The number of lines of magnetic flux per unit area cross-section of a magnetic circuit; also called magnetic *Induction*, including the lines due to the magnetisation of the iron, etc., as well as those due to the field due to external sources; measured

in lines per sq. cm. cross-section (Gausses), usually denoted by B and equal to $4\pi J + H$, where J = the intensity of magnetisation of the medium and H = the magnetising force. (All these are vector quantities having direction as well as magnitude.) (2) The term is also used for the flux per unit area in electrostatic fields. Symbol: D .

Fluxmeter (Grassot). An instrument for measuring flux density by means of an exploring coil connected to a special form of moving coil ballistic galvanometer.

Flywheel Type Alternator. An alternator in which the field system consists of poles fixed to the rim of a heavy flywheel, so that a separate flywheel is not required.

Foot, Magnetic. See **MAGNETIC FOOT**.

Focus Lamp. An incandescent lamp with the filament concentrated to obtain a source of light of small dimensions for use in projectors.

Focus Tube. The early type of "X" Ray Tube in which the concave form of the cathode causes the cathode rays to be focused or concentrated on the *Anti-cathode*.

Focusing: Electrostatic, Gas, Ionic, and Magnetic. See **ELECTROSTATIC FOCUSING, GAS FOCUSING, etc.**

Focusing Arc Lamp. An arc lamp in which the feeding mechanism is so arranged that the position of the arc does not alter as the carbons burn away.

Focusing Coil (in a Cathode Ray Tube). A coil surrounding the tube near the cathode producing a longitudinal magnetic field, which has the effect of concentrating the electron jet. Cf. **ELECTROSTATIC FOCUSING** and **IONIC FOCUSING**.

Focusing Electrodes. Electrodes provided in a *Cathode Ray Tube* to produce concentration of the electron beam.

Foot-Candle. A unit of *Illumination*; being the intensity of illumination given by a source of one candle-power at a distance of one foot on a surface at right angles to the rays, equal to 10.764 lux. (Sometimes written **CANDLE-FOOT**.)

Foot-Candle Meter. A form of portable illumination photometer with

a row of "grease spots" receiving gradual illumination from a standard lamp.

Foot-Lambert. A practical unit of *Brightness* proposed in America, differing from the *Lambert* in being that corresponding to an illumination of one lumen per sq. ft. instead of per sq. cm., i.e. one foot-candle.

Foot Switch. A switch actuated by the foot.

Force, Coercive. See **COERCIVE FORCE**.
Force (Electric). The strength of an electrostatic field at any point, as measured by the force in dynes exerted on unit charge if concentrated at that point. Also called *Electrostatic Field Strength* and *Intensity of Electric Field*. Symbol: E .

Force: Directive, Electromotive, Electrostatic, Lines of, Magnetic, Magnetomotive, Portative, Tubes of, Versorial. See **DIRECTIVE FORCE, ELECTROMOTIVE FORCE, etc.**

Forced Commutation. Commutation in which the completion of the extinction of the current in a coil is hastened by a flux in the contrary direction to that which has induced it, provided by a commutating pole or otherwise.

Forced Oscillations. Oscillations, due to an external cause; of a frequency generally different from the natural frequency of the circuit in which they are set up.

Forced Ventilation. The ventilation of a machine or apparatus by a current of air forced through it under pressure by a fan, etc. Cf. **INDUCED VENTILATION**.

Fork Connection. See **DOUBLE ZIG-ZAG CONNECTION**.

Forked Lightning. A popular name given to lightning flashes when their irregular flickering course can be distinctly seen. Cf. **SERPENT LIGHTNING**.

Forked Repeater. A telegraph repeating equipment which enables messages to be repeated to two stations in different directions from the repeating station without interfering with their ability to read each other's signals.

Form, Field. See **FIELD FORM**.

Form Factor. The ratio of the

effective or root-mean-square value of an alternating e.m.f., current, etc., to its true mean value. Symbol *K*.

Form Factor Indicator or Meter.

An instrument for indicating the *Form Factor* of an alternating voltage by comparing the *R.M.S.* and *Mean Values* by a rectifier bridge method.

Formed (Accumulator) Plate. See *PLATE TYPE OF ACCUMULATOR*.

Former. A frame on which a coil is wound, or a tool to give it the correct shape, afterwards removed when the coil is complete. Sometimes incorrectly used for a *Bobbin* or *Spool* remaining permanently within the winding.

Former Wound Coil. An armature coil made by winding on a former and completed by spreading or other treatment, so that it can be slipped directly into the slots.

Forming Accumulator Plates. The process by which the active material in accumulator plates is converted finally to the correct chemical composition for retaining the charge, by prolonged charging and discharging of the complete cell.

Forward Lead or Shift (of Brushes).

Angular displacement of brushes from the neutral open circuit position in the same direction as that of the rotation of the commutator, as usually required for sparkless commutation in a dynamo. Cf. *BACKWARD LEAD*.

Foucault Currents. Another name for *Eddy Currents*.

Four Channel Duplex Telegraph System. A variety of *Voice Frequency* system used on minor two-wire circuits in which some different frequencies are used in each direction.

Four Core Cable. A cable with four separately insulated *Cores* under one external covering.

Four Electrode Valve. A *Thermionic Valve* with four electrodes, e.g. with the usual *Filament* and *Plates* and an additional *Grid* in an additional *Plate*. (Also called *Tetrode* or *Quadrode*.) See *SCREENED GRID VALVE*, *SPACE CHARGE GRID*, and *DOUBLE PURPOSE VALVE*.

Four-Phase System. A name sometimes given to a two-phase, four-

wire system when the centres of the two phases are star connected to form a neutral point.

Four-Valve Receiver. See *VALVE RECEIVER*.

Four-Wire Circuit (in Telephony). A circuit using a separate pair of wires for speech in different directions, employed particularly in long lines with repeaters as permitting of a higher degree of amplification and reduction of *Cross Talk*.

Four-Wire Repeater. See *FOUR WIRE CIRCUIT*.

Four-Wire System. A system of distribution in which four mains are used. Applied to two-phase systems where the two phases are kept separate without a common wire, and to three-phase star-connected systems where an additional and usually earthed main is taken from the neutral point.

Fourth Rail. An additional insulated contact rail, used in traction systems either to supplement the conductivity of the running rails or to avoid taking the return current through the running rails.

Fourth Wire. The neutral wire in a three-phase four-wire distribution system.

Fractional Pitch Winding. An Armature winding in which the *Winding Pitch* is less than the pole pitch. Cf. *FULL PITCH WINDING*.

Frahm Frequency Meter. See *VIBRATING REED INSTRUMENTS*.

Frame. The part of a machine which supports the core or poles carrying the fixed windings, or in general a supporting structure for any kind of apparatus.

Frame: Box Type, Cheek Type, Distribution, Girder Type, Magnet, Resistance, Split, Standard, Stator, and Tie-Rod Type. See *BOX TYPE FRAME*, *CHEEK TYPE FRAME*, etc.

Frame Aerial. A compact and portable form of *Aerial* for receiving purposes composed of a flat coil of wire forming a rectangular (or polygonal) frame, and not connected to earth, having marked directional and selective quality, and responding to the magnetic rather than the electrostatic component of the wave.

Frame Cooled Motor. An enclosed motor cooled by blowing air from a fan over the ribbed outside of the case.

Frame Frequency (in Television). The number of times per second that the whole frame is covered during *Scanning*. Cf. *Picture Frequency*.

Frame-Type Switchboard. See *Skeleton-Type Switchboard*.

Franklin Aerial. A form of aerial used in short wave wireless telegraphy in which several sections, each the length of half a wave, are used one above the other with *Phasing Coils* between them to reverse the phase in alternate sections.

Free Charge. In the earlier theories, an electric charge was said to be "free" when not associated with a neighbouring charge of opposite sign by which it is "bound."

Free Handle Circuit-Breaker. A *Circuit-Breaker*, in which the releasing mechanism disconnects the handle from the contacts in a way which prevents it being held closed on an overload, etc.

Free Hearth Electrode Furnace. A *Direct Arc Furnace* in which one electrode in the hearth, at the bottom of the furnace, is in contact with the charge. Cf. *Buried Hearth Electrode Furnace*.

Free Oscillations. Oscillations of the natural frequency of the circuit in which they take place. Cf. *Forced Oscillations*.

Free Pole. A magnet pole imagined, for theoretical considerations, to be unassociated with the corresponding opposite pole.

Free Trip. A *Tripping Device* independent of the operating mechanism.

French Wire Gauge. A wire gauge in use in France in which the higher numbers are given to the larger sizes of wire and the difference between diameters of successive sizes is an integral number of tenths of millimetres increasing as the wire gets larger.

Frenophone. A form of loud speaking telephone in which the diaphragm is actuated by variation in the frictional drag of a brake

on a revolving cylinder of cork, or other material produced by control of the mechanical pressure by the telephone current. Cf. *Edison* (Loud Speaking) *Telephone*, or *Electromotograph* and *Electrostatic Adhesion Telephone*.

Frequency. The number of complete *Cycles* (or double waves) which an alternating current, a.n.f., etc., executes per second. Symbol: *f*. The name *Hertz* has been proposed for a unit of frequency of one cycle per second. See also *Kilocycle* and *Megacycle*. Cf. *Periodicity*.

Frequency: Audio-, Carrier, Cut-off, Frame, Fundamental, Group, High, Impulse, Industrial, Infra-Acoustic, Line, Picture, Radio, Sonic, Spark, Speech, Strip, Sub-Audio, Supersonic, Supertonic, Supra-Acoustic, Vision, and Voice. See *Audio-Frequency*, *Carrier Frequency*, etc.

Frequency Band. A term used in wireless telegraphy, etc., for the whole of the range of frequencies between certain limits.

Frequency Changer or Frequency Converter. (1) An apparatus which converts a current at one frequency into a current at another frequency, such as an alternator driven by a synchronous motor, or an apparatus similar to an induction generator. (2) The additional apparatus including a local oscillator in a superheterodyne receiver for producing the intermediate frequency. See also *Static Frequency Changer*.

Frequency Changer, Electron Coupled, Mercury Vapour, and Static. See *Electron Cooled Frequency Changer*, *Mercury Vapour Frequency Changer*, etc.

Frequency Demultiplier. An apparatus for obtaining sub-multiples of a fundamental frequency or "subharmonics" by means of resonant circuits.

Frequency Distortion. Alteration of the quality of reproduced sound in wireless telephony due to reproduction of different frequencies in different ratios. (Also called *Tone Distortion*.) Cf. *Amplitude Distortion*.

Frequency Divider. See FREQUENCY DEMULTIPLIER.

Frequency Doubler. See STATIC FREQUENCY CHANGER.

Frequency Filter. A network of inductance, capacitance and resistance designed to offer as little opposition as possible to currents at of a certain range of frequencies and as much as possible to currents of all other frequencies. See references under FILTER.

Frequency Indicator or Frequency Meter. An instrument for the measurement of *Frequency*; depending on the resonance of tuned reeds (see VIBRATING REED INSTRUMENTS), or on the fact that a current in a non-inductive circuit does not vary with the frequency whereas that in a circuit containing inductance but negligible resistance, is inversely proportional to the frequency. Various methods are made use of to combine the effect of these fixed and varying currents, so as to give a direct reading pointer. In some cases, a condenser is used instead of an inductance, when the current is directly proportional to the frequency. Other principles used are electrical resonance and the balancing effect of magnetic attraction and repulsion due to induced currents in a moving system containing iron.

Frequency Meter, Integrating. See INTEGRATING FREQUENCY METER.

Frequency Modulation. *Modulation* by variation of frequency of the carrier wave instead of variation of its amplitude.

Frequency Multiplier. See STATIC FREQUENCY CHANGER.

Frequency Relay. A relay which comes into action when the frequency of a system departs from the normal by more than a certain margin. Sometimes used to actuate the change-over switches of *Two Rate* motors, or to connect or to disconnect a group of circuits when required by making a momentary alteration of the frequency.

Frequency Stabilizer. An auxiliary oscillating system of very constant frequency, such as a piezo-electric

resonator used for control of the frequency of the main oscillating system of a wireless transmitter.

Frequency Teller. A name used, particularly in wireless telegraphy, for a *Frequency Meter*.

Frequency Tripler. See STATIC FREQUENCY CHANGER.

Friction : Brush and Magnetic. See BRUSH FRICTION and MAGNETIC FRICTION.

Friction and Windage Loss. The portion of the energy losses in dynamo-electric machinery due to the mechanical effects of friction and air resistance.

Friction Compensation. The provision of an auxiliary torque in a meter to compensate for friction at light loads, such as a strip of iron in an induction meter which produces an unsymmetrical flux distribution.

Frictional Electric Machine. A machine for producing electric charges by frictional action; such as a rotating glass cylinder, plate or globe rubbing against a prepared pad and passing by a conductor by which the charge is collected; now superseded by *Influence Machines*. In the earliest form made by Otto van Guericke at Magdeburg in 1671, a silk cloth held in the hand was applied to a rotating globe of sulphur.

Frictional Electricity. Electric charges produced by the rubbing together of dielectrics or insulated conductors. Used to describe static electricity in general before other methods of producing it were known. According to recent views it is doubtful whether it is actually the friction which produces the charge. This may be due rather to separation of the surfaces which by great reduction of the capacitance between them may raise very considerably the potential of a small charge due to a contact effect between the dissimilar materials. (Sometimes called *Tribo-Electricity*.)

Frictional Series. A list of materials arranged so that those higher in the list become positively electrified when rubbed with those following.

Fringing. The spreading of the lines of force in the air-gap from the edges of poles, teeth, etc.; complicating the calculation of the field in the gap.

Fringing Coefficient. The factor by which the pole face area must be multiplied to give the effective area of the air-gap. (Also called *Spreading Coefficient*.)

Frog Leg Armature Winding. A lap winding with a wavewinding in the same slots for equalisation purposes.

Front (of a Brush). Properly the *Entering Edge*, but often used of the *Leaving Edge*.

Front Contact Spring (in Telephony). A spring which makes contact with a main contact spring in the operating position.

Front Pitch. The winding pitch at the commutator end of an armature. Cf. *BACK PITCH*.

Frosted Lamp. An incandescent lamp with the bulb etched or sand-blasted to diffuse the light.

Frying. A term sometimes used for the hissing of an arc or the crackling noise heard in a telephone due to minute sparks or arcs in a carbon microphone.

Frying Pan (Electric). A frying pan containing an embedded heating element connected to a flexible cord.

Fulguration. See *DIATHERMIC SURGERY*.

Fulgurite. A vitrified tubular mass, sometimes found in the ground, particularly when of a sandy nature, where lightning has struck the earth, due to the intense local momentary heating effect. At one time thought to be the actual "thunderbolt" or material projectile forming lightning.

Full Excitation. The maximum excitation for which a field magnet winding is designed; or, in practice, that obtained when the whole of the regulating resistance is cut out of circuit.

Full Load. The greatest load which a machine or piece of apparatus is designed to carry under specified conditions. Any higher load is called an *Overload*. See *RATING*.

Full Load Characteristic. A curve exhibiting the relation between

terminal voltage and excitation at full load current.

Full Parallel Notch or Position. The position of a series-parallel controller in which the motors are in parallel with all resistance cut out, i.e. the full speed running position unless there is provision for a higher speed by weakening the fields.

Full Pitch Winding. The ordinary type of armature winding in which the span of each coil is the same as the pole pitch. Cf. *FRACTIONAL PITCH WINDING*.

Full Series Notch or Position. The position of a series-parallel controller in which the motors are in series with all resistance cut out, i.e. the low speed running position.

Full Wave Rectification. *Rectification* in which the half waves of an alternating current in both directions are utilized by reversing every alternate half-wave. (Also called *Two-Wave Rectification*.) Cf. *HALF-WAVE RECTIFICATION*.

Fuller-Board. A fibrous material used for insulating and protective purposes resembling *Press-Board*.

Fuller Cell. A two-fluid variety of the *Bichromate Cell*, made up in various different ways.

Fullerphone. A telegraph apparatus used for military purposes in which Morse messages, consisting of very small direct currents in the line, are read in a telephone receiver by breaking the current up by a local vibrator which, owing to an arrangement of condensers and inductances, does not affect the continuity of the current in the line.

Fully Automatic Substation. See *AUTOMATIC SUBSTATION*.

Fully Enclosed Motor. A motor enclosed in a case entirely without provision for natural ventilation, but not necessarily absolutely water tight. Cf. *FLAME-PROOF*, *PIPE-VENTILATED*, *PLATE PROTECTED*, *PROTECTED*, and *SEMI-ENCLOSED MOTORS*.

Fultograph. A simplified form of apparatus for transmission and reception or "still pictures" by wireless *Phototelegraphy* suitable for broadcasting purposes, in which the picture on the revolving drum

in the receiver is produced by the action of a current between the stylus and the drum on chemically prepared paper. The synchronisation is effected by starting each revolution of the drum separately by a clutch on receipt of the synchronising signal.

Fundamental Component. The component of the wave form of an alternating current, e.m.f., oscillation, or wave that is a pure sine wave of the principal frequency, upon which harmonics at various higher frequencies may be superposed.

Fundamental Frequency. The frequency of the fundamental component of oscillations, etc.

Fundamental Oscillations. Oscillations at the *Fundamental Frequency*.

Fundamental Units. The independent units of length, mass and time upon which a system of derived units is founded. See C.G.S. SYSTEM.

Fundamental Wave. See FUNDAMENTAL COMPONENT.

Fundamental Wavelength. The wavelength corresponding to the *Fundamental Frequency* of the oscillations in a particular circuit, upon which *Harmonics* may or may not be superposed. Symbol: λ .

Funicular Railway. A railway up a steep incline in which the cars are drawn up by a wire rope by a fixed electrically driven haulage drum or sheave. Cf. RACK RAILWAY.

Furnace (Electric). An apparatus in which a high temperature is obtained electrically either by means of an arc between separate electrodes or between electrodes and the charge to be heated, or by the flow of a current through a resistance which may or may not form a part of the charge; employed for a great variety of metallurgical and chemical operations, including manufacture of calcium and silicon carbides fixation of nitrogen, and the metallurgy of iron and steel as well as of non-ferrous metals and alloys. (No attempt has been made here to deal with more than

a few typical forms of electric furnace.)

Furnace: Acheson, Aluminium, Arc, Baily, Birkeland and Eyde, Buried Hearth-Electrode, Canley, Cathode-Ray, Cowles, Direct-Arc, Double-Current, Electrolytic, Electrometals, Free Hearth-Electrode, Girod, Greaves-Etchells, Helberger, Hering, Héroult, Indirect Arc Induction, Island Keller, Kilburn Scott, Kjellin, Lorenzen, Mignet, Moissan, Moscicki, Northrup, Pauling, Radiation, Rennerfelt, Resistance, Resistor, Roehling, Salt-Bath, Schoenherr, Series-Arc, Snyder, Stassano, Stobie, Tinfos, Valve-Operated Induction, and Wild Barfield. See ACHESON FURNACE, ALUMINIUM FURNACE, etc.

Furnace Regulation, Magnetic. See MAGNETIC FURNACE REGULATION.

Fuse. (1) A wire or strip of metal, mounted in suitable fittings, designed to melt and to interrupt the circuit when a predetermined maximum current is exceeded. (2) An apparatus for electrically firing explosives, consisting of a case containing the necessary priming charge and a wire heated by the current which passes when the firing key is depressed.

Fuse: Bi-metal, Boric Acid, Bridge, Carbon Tetrachloride, Cartridge, Enclosed, Expulsion, Handle Type, Home Office, Horn Break, Immersed Liquid-Quenched, Magnetic Blow-Out, Oil-Break, Open, Plain, Plate, Plug, Potential, Protected, Quick-Break, Screw-Plug Cartridge, Semi-enclosed, Semi-immersed, Liquid-quenched, Spark-let, and Tube. See BI-METAL FUSE, BORIC ACID FUSE, etc.

Fuse Board. A board on which several fuses are mounted. Cf. DISTRIBUTION BOARD.

Fuse Box. An enclosed *Fuse Board*.

Fuse Carrier. A removable holder for a *Fuse Link* which can be plugged into fixed contacts.

Fuse Cartridge. A *Fuse Carrier* complete with *Fuse Link*, as used in a *Cartridge Fuse*.

Fuse Element. See FUSE LINK.

Fuse Holder. See FUSE CARRIER.

Fuse Link. The actual fusible metal strip or wire in a *Fuse* or *Cut-Out*.

Fuse Panel. A panel or part of a switchboard on which are mounted a number of fuses.

Fuse Switch. A *Switch* carrying *Fuses* on its moving parts.

Fuse Tongs. Tongs with insulating handles for withdrawing and replacing high tension fuses.

Fuse Wire. Wire of an easily fusible material such as tin or tin and

lead for fuses. (Other metals, including copper, silver and aluminium are also used for fuses).

Fusible Cut-Out. See *FUSE* (1).

Fusing Current. The value of the current at which a given fuse will melt.

Fusing Factor. The ratio of the minimum fusing current to the rated carrying current of a fuse.

Fusing Point. The temperature at which a particular material will melt.

G]

G or **g**. Symbol for *Conductance*.

Gadolinium. A recently discovered rare *ferromagnetic* metal.

Gain, Repeater. See **REPEATER GAIN**.

Gain Control, Automatic. See **AUTOMATIC GAIN CONTROL**.

Gallery. A device for attaching glass and other shades to electric light fittings by holding them by means of screws or clips which engage in a groove or behind a flange in the shade. The hole in the shade is of considerably larger diameter than the lamp holder. Cf. **SHADE CARRIER RING**.

Gallery, Switchboard. See **SWITCHBOARD GALLERY**.

Galvanic. The term "galvanic" derived from the name of L. Galvani of Bologna (1737-1798), like the term *Voltaic*, was at one time used to distinguish electricity flowing as a current from electrostatic phenomena. Galvani, who was an anatomist, noticed activation of the nerve of a freshly killed frog's leg when touched by dissimilar metals in contact, but thought that the cause was entirely physiological, while Volta attributed it to the contact of the metals, but Galvani, in 1792, discovered the part played by the chemical action.

Galvanic Battery. Old-fashioned term for an ordinary primary battery.

Galvanic Belt. See **BELT (Electric)**.

Galvanic Current. A unidirectional uninterrupted current. See **GALVANIC** and **GALVANISM**.

Galvanic Electricity. See **GALVANIC**.

Galvanic Pile. See **VOLTAIC PILE**.

Galvanic Taste. The distinctive taste experienced when the tongue touches two dissimilar metals in contact with each other, due to the e.m.f. produced, or when two wires between which there is a small e.m.f. are brought in contact with the tongue. Discovered by Sulzer in 1767.

Galvanisation. The curative applica-

tion of uninterrupted unidirectional currents.

Galvanising, Electro-. See **ELECTRO-GALVANISING**. (Ordinary galvanising of sheets of iron, i.e. coating them with zinc is not an electrical process.)

Galvanism. (1) The science of electric currents. (2) In electrotherapeutics, curative treatment by uninterrupted unidirectional currents.

Galvano-cauterisation. Cauterisation by an electrically heated wire.

Galvano-cautery. An electrically heated cautery apparatus.

Galvanograph. See **ELECTROTYPE**.

Galvanology. An old term for the science of electric currents.

Galvanomagnetism. An old term for the magnetism produced by an electric current.

Galvanometer. An instrument for measuring currents of small magnitude.

Galvanometer: **Absolute**, **Astatic**, **Ayrton-Mather**, **Ballistic**, **Broca**, **D'Arsonval**, **Differential**, **Einthoven**, **Helmholtz**, **Loop**, **Marine**, **Mirror**, **Moving-Coil**, **Moving Magnet**, **Potential**, **Reflecting**, **Sine**, **String**, **Tangent**, **Thermo-**, **Torsion**, **Torsion String**, **Twisted Strip**, **Versatile**, and **Vibration**. See **ABSOLUTE GALVANOMETER**, **ASTATIC GALVANOMETER**, etc.

Galvanometer Constant. A number by which a certain function of the reading of a galvanometer must be multiplied to give the value of the current in ordinary units.

Galvanometer Shunt. A resistance put in parallel with a galvanometer to reduce its sensibility by allowing only a known fraction of the current to pass through it. See **UNIVERSAL SHUNT**.

Galvanoplastic. Relating to the process of "galvanoplasty."

Galvanoplasty. See **ELECTROFORMING**.

Galvano-Puncture. See **ELECTRO-PUNCTURE**.

[Gal

Galvanoscope. An instrument for detecting but not measuring a current.

Galvano-Therapy. See ELECTROTHERAPY.

Galvano-Tropism. See ELECTROTROPISM.

Gamma (γ) Rays. The most penetrating of the three principal kinds of rays given out by radio-active bodies; undeflected by a magnetic field, capable of exciting fluorescence and consisting of ether waves of very short wave length (from 0.06 to 1.4 Angstrom units), shorter than that of most "X" Rays, and therefore more penetrating. Cf. α , β , and δ RAYS.

Gamma (I) Type Aerial. See INVERTED "I" TYPE AERIAL.

Gang Condensers (in Wireless Receiving Apparatus). Two or more variable condensers belonging to successive stages of amplification coupled together to be worked simultaneously by one dial. Usually with a small balancing condenser connected to each for fine adjustment.

Gang Control. Control of a number of similar pieces of apparatus by one operation, e.g. the speed control of a number of motors driving printing telegraph instruments from one tuning fork apparatus.

Gang Switches. A number of switches, belonging to different circuits, mechanically coupled together, permanently or temporarily, to be worked simultaneously, e.g. in stage switchboards, etc.

Gap: Air, Anchor, Horn, Micro-meter, Needle-point, Spark, and Sphere. See AIR GAP, ANCHOR GAP, etc.

Gap Arrestor. A name sometimes applied to the type of lightning or surge arrester in which a number of gaps in series are provided between cylinders or cones, usually of a metal such as zinc not liable to arcing. See MULTI-GAP ARRESTER.

Gap Extension Coefficient. The coefficient by which the actual slot width must be multiplied to obtain the equivalent slot width, after allowing for fringing.

Gap Reluctance. The ratio of the magnetomotive force to the flux across the air gap. See RELUCTANCE.

Garton Lightning Arrester. A form of *Lightning Arrester* in which the passage of a discharge through a carbon resistance in series with the gap gives a sufficient potential difference to excite a solenoid, causing it to draw up a plunger, and to increase the gap so as to extinguish the arc.

Gas Battery. See GROVE'S GAS BATTERY.

Gas-Blast Switch. A switch for high voltages in which a blast of hydrogen or other gas is directed on to its arc at the moment of separation of the contacts to accelerate its extinction.

Gas Coulomb-Meter or Coulometer. See GAS VOLTAMETER.

Gas Detector. An instrument in which the presence of inflammable gas in mines, etc., can be detected and caused to operate relays disconnecting electric circuits. In one system an electrically heated filament in a porous vessel burns up any gas that has entered, causing a diminution of pressure which actuates diaphragm contacts.

Gas Discharge Lamp. See DISCHARGE LAMP.

Gas Discharge Tube. A *Vacuum Tube* in which the vacuum is not too high for a discharge to pass without special means of electron projection, such as a heated cathode, i.e. with a gas pressure not lower than about 2 millionths of an atmosphere. Cf. ELECTRON TUBE.

Gas-Electric Car. See PETROL-ELECTRIC TRACTION.

Gas-Electric Generating Set. An expression used (principally in America) for a generating set driven by a gas or petrol (gasoline) engine.

Gas-Filled Cable. A form of *Gas Pressure Cable* in which the gas under pressure is included in spaces provided within the lead covering.

Gas-Filled Lamp. A high efficiency tungsten filament lamp in which the disintegration of the filament

and blackening of the bulb liable to occur with filaments run in a vacuum is prevented by filling the bulb with an inert gas such as nitrogen or argon, which is at about atmospheric pressure when the lamp is hot.

Gas Focusing. See IONIC FOCUSING.

Gas-Impregnated Cable. A high voltage cable with insulation composed of dry paper without oil impregnation in an inert gas at a pressure maintained at over 200 lbs. per sq. in.

Gas Lighter (Electric). A portable apparatus containing a small influence machine for producing sparks for igniting gas jets, etc.

Gas Meter (Electrical). A gas meter using electrical methods of integration.

Gas Pressure Cable. A high voltage cable in which the insulating medium is subjected to mechanical pressure to increase its electrical breakdown strength by the inclusion of inert gas under pressure within a suitable enclosing tube.

Gas Sentinel. See GAS DETECTOR.

Gas Tube. See GAS DISCHARGE TUBE. A term more particularly applied to "X" Ray tubes without heated cathodes.

Gas Voltmeter. An apparatus for measuring current by observing the amount of gas produced by electrolyzing water, etc.

Gaseous Discharge. The discharge of electricity through gases at low pressure (see VACUUM TUBE). The discharge consists of movement in one direction of *Negative Carriers*, consisting (in high vacua) of free electrons and in the other direction of positive carriers of greater mass, consisting of gaseous ions. See also POSITIVE RAYS.

Gassing. The copious evolution of gas in an accumulator cell when the charging current is continued after the charge is complete.

Gate By-pass Switch (in an Electric Lift). A switch in the car for allowing the car to be moved in emergency when all the gates are not closed.

Gate-Change Switch. A multiway switch arranged with fixed contacts in more than one plane, and

the handle moving in guide slots similar to those of an automobile change speed gear of the gate type.

Gate Contact (in an Electric Lift). See GATE SWITCH.

Gate-end Box. A cable box forming work where a joint is made to a flexible or trailing cable.

Gate Interlock. A combination of a GATE SWITCH and AUTOMATIC GATE LOCK.

Gate Lock. See GATE SWITCH.

Gate Lock, Automatic. See AUTOMATIC GATE LOCK.

Gate Switch (in Electric Lift Control). A switch actuated by the opening and closing of the gates, which prevents the lift being started unless all the gates are closed and stops it if a gate is opened when the car is in motion.

Gauge : Ampere, Battery, Electrometer, and Wire. See AMPERE GAUGE, BATTERY GAUGE, etc.

Gauss. The name now adopted for the C.G.S. Unit of *Flux Density* being one *Maxwell* per sq. cm. (Formerly used to some extent for the unit of *Magnetic Force*, now called the *Oersted*.)

Gaussian Units. A system using electrostatic units for purely electrical quantities and electromagnetic units for magnetic quantities.

Gaussmeter. A direct reading instrument for measuring magnetic field strength.

Gauze Brushes. Dynamo *Brushes* of copper gauze; capable of higher current density than carbon brushes but not giving such good conditions of commutation in most cases.

Gauze Protection. The rendering of motors or other apparatus flame tight, while allowing of a certain amount of ventilation, by covering all apertures with wire gauze.

Geared Locomotive. An electric locomotive in which the motors drive the axles through speed reducing gearing. Cf. GEARLESS LOCOMOTIVE and SIDE ROD DRIVE.

Geared Motor. A motor driving through gearing. See also BACK GEARED MOTOR.

Geared Turbo-Generator. A generator driven through speed reduction

- gearing by a steam turbine, to enable both to run at their most efficient speeds, particularly in the case of direct current machines.
- Gearless Locomotive.** An electric locomotive driven by *Gearless Motors*.
- Gearless Motor.** A traction motor, the armature or rotor of which is either mounted directly upon the axle or drives it through some form of flexible coupling without speed reduction gear.
- Gehrcke Oscilloscope.** See *OSCILLOSCOPE*.
- Geissler Discharge.** The broken-up luminous discharge seen in a *Geissler Tube*.
- Geissler Tube.** A *Vacuum Tube* with a moderate degree of exhaustion sufficient for the brightly coloured luminous discharge to be broken up by dark spaces, i.e. with a gas pressure below about 1/100 of an atmosphere. Cf. *GLOW DISCHARGE* and *CROOKES TUBE*, and see *NEGATIVE GLOW*, *POSITIVE COLUMN*, *FARADAY DARK SPACE*, *STRIBEL*, *CROOKES DARK SPACE*, *CATHODE GLOW*, and *ANODE GLOW*.
- Generating Electrostatic Voltmeter.** An instrument for measuring high voltages by observing the charging current to a capacitor of varying capacitance, one electrode of which is driven by a synchronous motor. Also called *ROTARY VOLTMETER*.
- Generating Plant.** The complete machinery and apparatus required for the production of electrical energy for power or lighting, whether in a large power station or in a private installation.
- Generating Plant, Automatic and Isolated.** See *AUTOMATIC GENERATING PLANT* and *ISOLATED GENERATING PLANT*.
- Generating Set.** One or more generators complete with the engine, turbine, etc., which drives them.
- Generating Set: Gas-Electric, Hydro-Electric, Petrol-Electric, and Steam-Electric.** See *GAS-ELECTRIC GENERATING SET*, *HYDRO-ELECTRIC GENERATING SET*, etc.
- Generating Station.** A works where electrical energy for distribution for lighting, power or traction purposes, etc., is produced from

dynamo-electric machinery driven by water-power, steam engines or turbines, gas or oil engines or otherwise.

- Generator.** A machine or apparatus for the conversion of mechanical power into electrical energy, i.e. a *Dynamo* or an *Alternator*; occasionally applied also to apparatus for the production of electric currents from other than mechanical forms of energy, e.g. *Thermo-electric Generator*, or to apparatus for producing electric waves.
- Generator: Acyclic, Alternating Current, Arc, Asynchronous, Compound Wound, Consequent Pole, Constant Current, Constant Power, Constant Voltage, Direct Coupled, Direct Current, Double Current, Electromagnetic, Heteropolar, Homopolar, Impulse, Induction, Innerpole, Lightning, Magneto, Milking, Multifrequency, Multipolar, Noise, Non-Polar, Overtone, Polyphase, Pyromagnetic, Reaction, Ringing, Salient Pole, Secondary, Self-Excited, Separately Excited, Series-Wound, Shot-Firing, Shunt-Wound, Single-Phase, Surge, Synchronous, Thermionic, Thermo, Thermo-Chemical, Thermo-Electric, Thermo-Magnetic, Three-Phase, Tonic, Traction, Transformer, Turbo-, Two-Phase, Under-type, Unipolar, Variable Voltage, Welding, and Wind-driven.** See *ACYCLIC GENERATOR*, *ALTERNATING CURRENT GENERATOR*, etc.
- Generator Bus-Bars.** Main conductors on a switchboard to which several generators are connected in parallel. Cf. *FEEDER BUS-BARS*.
- Generator Panel.** A panel or part of a switchboard upon which is mounted the switch-gear for connecting the generators to the bus-bars and regulating the voltage of each, together with the necessary instruments for the control of their output.
- Geo-electric Methods.** Investigations into the properties of the earth's crust by observations of distribution of electric potential or magnetic field.
- Geomagnetic Surveying.** Ascertainment of the position of mineral

features by magnetic measurements.

Geometrical Attenuation. Reduction of amplitude of free electric waves due to widening of the wave front at progressive distances from the source.

Geothermic Station. A generating station in which energy is obtained from the heat in the interior of the earth, e.g. by means of "natural" steam from subterranean hot springs or boilers fired by natural gas.

German Silver. An alloy of copper, nickel, and zinc used for resistances, usually in proportions of about 62, 16 and 22 respectively.

G.E.S. Lamp Cap. See GOLIATH EDISON SCREW CAP.

Getter. A name given in thermionic valve manufacture to a small piece of magnesium, or similar metal, attached to the anode, which is heated after the lamp is exhausted and sealed, so that it volatilises, combines with the residual gases, improves the vacuum, and finally condenses on the bulb in a mirror-like deposit.

Ghost Working (in Telegraphy). The superposition of telegraph working on *Phantom* telephone *Circuits* to obtain an additional communication channel.

Gilbert. A name officially adopted for the unit of *Magnetomotive Force*; equivalent to $4\pi/10$ (or 0.7958) ampere turns. (Named after William Gilbert, 1540-1603.)

Gilding, Electro- See ELECTRO-GILDING.

Giles Valve. An arrangement of combining spark gaps and capacitance used as a surge arrester.

Giorgi System of Units. See M.K.S. SYSTEM.

Girder Type Stator Frame. A pattern of stator frame occasionally used for large diameter machines built up of iron plates riveted together.

Girod Furnace. A form of direct arc furnace in which a direct current arc is maintained between a single carbon electrode and the charge.

Gland: Armour, Watertight and Wiping. See ARMOUR GLAND, WATERTIGHT GLAND, etc.

Glim Lamp. A name sometimes used for a glow discharge lamp, such as a *Neon Lamp*.

Globe. A spherical or similar shaped glass vessel surrounding an arc or incandescent lamp for protective purposes or to diffuse the light. Cf. BULB.

Globe Photometer. See ULBRIGHT GLOBE PHOTOMETER.

Globe Strain Insulator. A strain insulator in which the metal parts to be insulated are in the form of separated but interlinked rings, round which a sphere of insulating material is moulded.

Globular Discharge or Globular Lightning. A form of electric discharge, rarely seen, and said to consist of a luminous ball moving slowly and exploding with a loud report and sufficient violence to cause considerable damage; possibly consisting of some form of brush discharge from a mass of air in a highly ionised state, or of unstable compounds of nitrogen and oxygen, or of ozone.

Gloodad Wiring System. A watertight and gastight wiring system in which special cables are employed with a lead alloy sheath which screws into the glands of the fittings and junction boxes.

Gloves, Indiarubber and Insulating. See INDIARUBBER GLOVES.

Glow: Anode, Blue, Cathode, and Negative. See ANODE GLOW, BLUE GLOW, etc.

Glow Discharge. (1) A silent and continuous form of luminous discharge appearing at points on conductors at a high potential. Cf. BRUSH DISCHARGE. (2) The continuous luminous discharge filling the whole tube taking place in a vacuum tube with comparatively low potential difference and moderate degrees of exhaustion (i.e. at gas pressures above 1/100 of an atmosphere). Cf. WEISSLER DISCHARGE.

Glow Discharge Anemometer. An instrument in which air-velocity is measured by the effect on the current through a constant potential *Glow Discharge* the fluctuations being suitably amplified and recorded on an oscillograph.

- Glow Discharge Lamp.** See GAS DISCHARGE LAMP.
- Glow Discharge Microphone.** A form of Telephone Transmitter in which modulations in the current across a glow discharge are produced by the direct action of the sound waves on the air.
- Glow Lamp.** A term formerly used for *Incandescent* (Electric) Lamp on account of possible confusion with incandescent gas lamps and now used for *Gas Discharge Lamps*.
- Glow Loud Speaker.** A sound-reproducing instrument dependent upon the direct action on the air of modulations in a *Glow Discharge*.
- Glow Tube.** A vacuum tube, such as a Neon tube, emitting a visible glow when a suitable voltage is applied at its terminals.
- Glower.** The incandescent conductor in a *Nernst Lamp*. Sometimes used for other conductors heated to incandescence by a current.
- Gold Leaf Electroscope.** An apparatus in which two pieces of gold leaf, joined at one end by a conductor in an insulating support such as a glass jar, are used to indicate the presence of a charge by diverging owing to their mutual repulsion.
- Gold Magnet.** A term given by the ancients to a precious stone (probably topaz) credited with the power of attracting gold.
- Goldschmidt High Frequency Alternator.** An alternator for producing currents at *Radio-Frequencies*, in which no attempt is made to provide a sufficiently high pole frequency, but the fundamental frequency is multiplied by introducing harmonics by means of oscillating circuits in connection with both the field and the armature. A cumulative effect is produced by the interaction between the stator and the rotor, and very high frequencies can be obtained.
- Goliath Edison Screw (G.E.S.) Cap.** A Lamp Cap similar to that described under *Edison Screw Cap*, but of larger size (about 1½ in. diam.) for large metal filament lamps.
- Goliath Edison Screw Holder.** A lamp holder for lamps with *Goliath Edison Screw Caps*.
- Goniometer, Electro- and Radio.** See ELECTRO-GONIOMETER and RADIO-GONIOMETER.
- Gott's Method** (of Capacitance Measurement). A bridge method of determining the capacitance of a cable by balancing the drop of potential across the dielectric of the cable and across a standard condenser against that across two sections of a slide resistance.
- Graded Brush.** A brush made of layers of material of varying resistance, so that the trailing end is of higher resistance than the leading end: sometimes also used of brushes simply of different lateral and longitudinal resistance.
- Graded Cable.** (1) A cable with insulation in layers of different material graded, according to Jona's method, with that of higher specific inductive capacity nearest to the conductor, to give improved distribution of the dielectric stress. (2) A cable with *Intersheaths*.
- Graded Insulation.** (1) Provision in transformers, etc., of thicker insulation at those parts where the potential between winding and earth may be much greater under certain conditions such as steep-fronted surges. (2) See GRADED CABLE.
- Gradient, Potential.** See POTENTIAL GRADIENT.
- Grading** (in Automatic Telephony). Connection of selectors in a way which gives a greater number of alternative paths in the later than in the earlier selecting operations.
- Grading Coefficient.** A term used in the design of motor starters and controllers for the ratio of the lower to the upper limit of current during starting.
- Grading Ring.** A metal ring near the end of a string of suspension insulators and connected to the conductor or earth with the object of regulating the potential gradient and taking the arc of a flash-over.
- Grading Shield.** See GRADING RING.
- Graduator.** An inductive resistance used in circuits employed for

simultaneous telegraphy and telephony, for slowing down the rate at which the telegraph currents rise and fall in order that they shall not affect the telephone receivers.

Gramme Calorie. See CALORIE.

Gramme Ring. A ring-armature with a smooth core without teeth. Cf. PACINOTTI RING.

Gramophone (Electric). A gramophone in which an electrical "pick-up" is employed to work one or more loud speakers. (See also SCRATCH FILTER.) Such apparatus can be made to give much purer reproduction than the mechanical gramophone and of a power sufficient for the largest theatres, cinemas, etc.

Gramophone, Radio. See RADIO-GRAMOPHONE.

Gramophone Attachment or Gramophone Pick-up. An appliance, replacing the sound-box of a gramophone, which converts the mechanical vibrations of the needle into corresponding pulsations in current. These can be amplified and fed to one or more loud speakers, or used for modulation in a broadcasting transmitter.

Grapher. See GRAPHIC INSTRUMENT.

Graphic Instrument. A measuring instrument arranged to make a continuous record of its indications on a travelling paper chart by means of a pen attached to its moving system or otherwise, also commonly called *Recording Instrument*.

Graphite Brush. A *Brush* made of the form of carbon known as graphite; more homogeneous and of higher conductivity than ordinary carbon as well as having the advantage of giving a certain amount of lubricating effect.

Graphite Resistance. (1) A compact form of high resistance made of a rod of graphite. (2) Variable resistances for motor starting, etc., made of piles of discs of graphitised cloth under variable pressure.

Graphitised Filament. See METALLISED FILAMENT.

Grassot Fluxmeter. See FLUXMETER.

Grätz Rectifier. A method of rectifying alternating currents in which four electrolytic valves are

employed per phase connected in the arms of a bridge so that both waves are used, feeding the circuit taken off from the bridge points from different directions alternately.

Gravity Cell. A two-fluid cell with horizontal electrodes, in which the different liquids used lie in layers kept separate by their difference in specific gravity without any porous diaphragm.

Gravity Control. Instruments are said to have "gravity control" when the controlling torque, against the torque due to the action of the current, is provided by gravity without the use of springs, etc.

Gravity Switch. See SWITCH HOOK (1).

Grease Spot Photometer. A photometer employing a screen with a spot of grease which when equally illuminated from either side ceases to show the spot as light on a dark ground from one side and dark on light ground from the other; also called *Bunsen Photometer*.

Great Calorie. See CALORIE.

Greaves-Etchells Furnace. A form of direct arc furnace for steel manufacture.

Grenz-Rays. "X" Rays of the softer or less penetrating type employed in some forms of *Radio-Therapy*, produced by voltages from 3 to 12 kV.

Grid. Anything made essentially of parallel wires or bars in one plane. Particularly a wire screen or auxiliary anode between the hot cathode and the plate anode in a *Thermionic Valve*. (2) The reticulated lead frame in a pasted type of accumulator plate in the interstices of which the active material is held. (3) See GRID RESISTANCE. (4) A network of high tension transmission lines interconnecting several power stations.

Grid: Accelerating, Accumulator, Damping, Potter-Bucky, Screen, and Space Charge. See ACCELERATOR GRID, ACCUMULATOR GRID, etc.

Grid A.C. Resistance. The ratio of a small change of grid-voltage to a

small change in grid-current, other quantities being constant. Symbol: r_g .

Grid Battery. A battery, sometimes consisting of a few dry cells, with or without a potentiometer, to apply a *Grid Bias* to a *Thermionic Valve*.

Grid Bias. A low and usually adjustable potential applied to the grid of a thermionic valve. A negative "Grid Bias" is often used to bring the action of an amplifier valve on the most sensitive part of the characteristic, to improve the quality of reception and to diminish the output of the h.t. battery. (Also called *Grid Potential* and *Bias Voltage*.)

Grid Bias Battery. See **GRID BATTERY**.

Grid Circuit. The circuit connected to the grid of a thermionic valve. Cf. **PLATE CIRCUIT**.

Grid Condenser. A condenser in the grid circuit of a thermionic valve in connection with cumulative grid leak rectification, resistance capacitance coupling, or to maintain a negative bias on the grid of an oscillating valve.

Grid Conductance (in a Thermionic Valve). The reciprocal of *Grid Resistance*.

Grid Control. (1) The control of the discharge in a discharge tube by varying the potential of a grid between the electrodes as in *Thermionic Valves*, *Mercury Arc Rectifiers*, etc. (2) See **GRID MODULATOR**.

Grid-Controlled Rectifier. See **GRID CONTROL** and **MERCURY VAPOUR RECTIFIER**.

Grid Current. The current flowing between the grid of a thermionic valve and another electrode; normally entering the valve by the grid and leaving by the filament. This will only flow if the grid has a slightly positive potential and can be prevented by a negative bias. Symbol: I_g or i_g . See **GRID POTENTIOMETER**.

Grid Current, Reverse. See **REVERSE GRID CURRENT**.

Grid Current Characteristics (of a Thermionic Valve). Curves connecting simultaneous values of (1) grid current and grid voltages, and

(2) grid current and anode voltage, all other variables remaining constant. Cf. **ANODE CURRENT CHARACTERISTIC**.

Grid Current Surface (of a Thermionic Valve). A surface connecting coordinates representing simultaneous values of *Grid Current*, *Anode Voltage*, and *Grid Voltage*. Cf. **ANODE CURRENT SURFACE**.

Grid D.C. Resistance. Of a thermionic valve: the ratio of the grid voltage to the corresponding grid current under steady current conditions, other quantities being constant. Symbol: R_g .

Grid Emission. A small amount of emission of electrons, liable to occur in some thermionic valves from the *Grid*, detrimental to the proper working of the valve.

Grid Excitation Circuit. A *Grid Potentiometer* or other arrangement for applying a *Grid Bias Potential*.

Grid Glow Relay. A vacuum-tube relay with an anode, a cathode, and an intermediate grid in an inert gas, such as neon. The current passing is due to the glow discharge between the anode and the cathode, and its amount depends on the voltage conditions of the grid.

Grid Leak. A high resistance (of a value of megohm or more) in parallel with a *Grid Condenser* of a thermionic valve to relieve the grid from excessive static charges but allowing it to retain a small negative potential.

Grid Leak Rectification. See **CUMULATIVE RECTIFICATION**.

Grid Modulator. A *Modulator* in a wireless transmitting apparatus which acts by applying the variations of the microphone current to the grid of the oscillating valve, either direct or through an intermediate valve circuit.

Grid Potential. See **GRID BIAS**.

Grid Potentiometer. A slide resistance carrying a current from a small battery for applying a variable *Grid Bias*, often used to give an adjustable positive grid potential to a high-frequency valve to produce just enough grid current to damp out self oscillation.

Grid Priming Voltage. See **GRID BIAS**.

Grid Rectification. Rectification of

a thermionic valve in which the oscillations to be rectified are applied to the grid circuit of the valve. See CUMULATIVE GRID RECTIFICATION.

Grid Resistance. See GRID D.C. RESISTANCE and GRID A.C. RESISTANCE.

Grid Resistor. A resistor for tramway motor control or other purposes, made up of units, each composed of a cast metal grid, threaded on long bolts from which they are insulated.

Grid Sweep. The range of voltage change under working conditions of the grid of a thermionic valve.

Grid Voltage. The voltage between the grid and the cathode in a thermionic valve. When the latter is identical with the heating filament, the voltage is measured from the negative terminal of a d.c. filament or the centre of an a.c. filament. Symbol: V_g or v_g .

Grid Voltage Swing. See GRID SWEEP.

Grinder, Commutator. See COMMUTATOR GRINDER.

Grip: Cable, Cord, and Earthing. See CABLE GRIP, CORD GRIP, etc.

Grooved Wire. Trolley wire with two V grooves that can be clipped mechanically by the cars. Cf. FIGURE EIGHT WIRE.

Ground. A term used (more especially in America) as a synonym to *Earth*, e.g. "ground wire," "grounded circuit," etc. To avoid repetition all references to this subject are here given under *Earth*.

Ground Aerial. An aerial laid on or near the ground.

Ground Rays. See DIRECT RAYS.

Group Automatic Lift Control. A class of automatic electric lift control for groups of lifts in which pressure of a call button on a landing calls the next available lift car.

Group Drive. Electric driving in a factory, etc., where each motor drives a group of several machines.

Group Frequency. The number of separate trains of waves per second in a spark or damped wave system of wireless transmission.

Group Selector (in Automatic Tele-

phony). A selector which makes connection with a desired group of links and then selects an idle link.

Grove's Cell. A cell similar to the *Bunsen Cell* but with a positive electrode of platinum instead of carbon.

Grove's Gas Battery. A primary cell forming a reversed water voltmeter, i.e. with electrodes consisting of platinum plates in contact with oxygen and hydrogen respectively and an electrolyte of acidulated water.

Guard, Lightning. See LIGHTNING GUARD.

Guard Cradle or Net. An earthed network of wires placed under overhead conductors at points where danger might be produced by their falling.

Guard Plate or Ring. (1) A ring or surface, surrounding a charged body such as the movable plate in an attracted disc electrometer, which ensures even distribution of the potential over it by making it virtually part of a much larger surface and eliminating the effect of the edges. (2) See GRADING RING.

Guard Wire. An earthed wire, above an overhead line, and to ensure their being earthed before coming into contact with the line to be protected, to catch other wires which may fall accidentally across the line. Cf. GUARD NET. See also PRICE'S GUARD WIRE.

Guide Cable. See LEADER CABLE.

Gulstad Relay. A sensitive form of telegraph relay in which the tongue is normally kept vibrating by an auxiliary winding at a speed equal to that of the reversals of current at the distant transmitter, so that the line currents only have to act in arresting the vibration of the tongue temporarily and holding it over against one stop.

Gun (Electric). A name sometimes given to Elihu Thomson's experiment of sudden repulsion of a metal ring from an alternating electromagnet.

Gun, Electron. See ELECTRON GUN.

Gundelach Tube. The type of "X"

Ray Tube commonly employed having an auxiliary anode in another part of the tube but externally connected to the *Anti-Cathode* or *Target*.

Gutta Percha. An insulating material made from the exudation of certain trees, used extensively for the insulation of submarine cables on account of being unaffected by immersion in water.

Guy. A temporary *Stay*.

Gymnotus Electricus. The Surinam Eel or *Electric Eel*.

Gyro-Magnetic Effect. Magnetisation due to spinning a ferromagnetic rod on its axis, or conversely a rotary torque produced by magnetisation, due to the fact that magnetisation is due to rotation of electrons within the atoms.

Gyrostatic Compass. A form of ship's compass, deriving its directive force from an electrically driven flywheel or gyrostator and independent of the earth's magnetic field.

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H. Abbreviation for *Henry*. Symbol for *Magnetic Field Strength*.

Hair-Dryer (Electric). A self-contained apparatus held in the hand containing a motor-driven fan and a heating element by which a current of warmed air can be blown through a nozzle.

Hair-Pin Winding. A winding pushed from the ends of the slots partly formed, the individual ends being afterwards welded together.

Half-Closed Slots (or **Partly Closed Slots**). Armature slots are sometimes made partly closed in at the top, i.e. with an opening narrower than the full width of the main part of the slot, forming a compromise between open slots and tunnels. Such half-closed slots have the advantage of lessening eddy-currents in the pole faces, but they increase the inductance of the armature coils and interfere with the dissipation of heat. They secure the conductors against centrifugal force much better than open slots and are easier to introduce the windings into than fully closed slots or tunnels. See **OPEN SLOTS**.

Half-Coiled Winding. An alternator armature winding with only one coil per phase per pair of poles, i.e. with alternate poles unsubtended by coils. Cf. **WHOLE COILED WINDING**.

Half-Deflection Method. A method of determining the internal resistance of a coil (when high) by finding the added resistance necessary to halve the deflection which a galvanometer of known resistance gives when the coil is connected to it in series with another known resistance.

Half-Normal Bend. A 135° bend for connecting two lengths of conduit tube.

Half-Watt Lamp. A name formerly given to *Gas-filled Lamps*, on ac-

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count of the specific consumption of some of them approximately to 0.5 watt per candle power.

Half-Wave Rectification. *Rectification* in which the half-waves of the alternating current in one direction only are made use of while those in the reverse direction are suppressed. (Also called *One Wave Rectification*.) Cf. **FULL WAVE RECTIFICATION**.

Half-Wave Transmission. Long distance alternating current transmission in which line losses and pressure drop are lessened by arranging the natural period of oscillation of the line to be equal to four times the frequency so that resonance is produced. Cf. **QUARTER WAVE TRANSMISSION**.

Half Wave-Length Aerial. A transmitting aerial with an effective height equal to half the wavelength of the waves to be radiated.

Hall Effect. An alteration of the distribution of a current sheet in a strip of metal by a magnetic field, which has the effect of rotating the direction of the lines of flow. The twisting effect is different with different metals, being to the right, looking along the lines of force in tellurium, iron, antimony, etc., and to the left in bismuth, nickel, gold, etc.

Halogen Accumulator. An experimental type of accumulator cell with zinc and carbon electrodes in an electrolyte of zinc iodide or chloride.

Hammer Break or Hammer Interrupter. The ordinary electromagnetic trembler employed to break the primary circuit of an induction coil intermittently, in which the attraction of the head separates the contacts thereby releasing itself and closing them over and over again. Cf. **MOTOR BREAK**.

Hand (of an Armature Winding, etc.).

The fact whether the individual coils or the general direction of the connection of the coils to the commutator segments is right handed or left handed, according to certain conventions as to the way the winding is traced out.

Hand Capacitance Effect. The effect of moving the hand close to the tuning condenser in upsetting the tuning, particularly with short waves; sometimes avoided by use of long handles or screening arrangements.

Hand Lamp. A portable fitting containing a suitably protected incandescent lamp connected to a flexible cable, or provided with a self-contained battery, used for inspection purposes, etc.

Hand Micro-telephone. A combined microphone and receiver arranged to be conveniently held in the hand with the receiver to the ear and the microphone a convenient distance from the mouth.

Hand-Regulated Arc Lamp. An arc lamp in which the striking of the arc and the feed of the carbons is effected entirely by hand adjustment; sometimes used in searchlight and other projectors. Cf. AUTOMATIC ARC LAMP.

Hand Regulation. Regulation of the voltage of a dynamo, etc., by hand adjustment of the field rheostat, etc.

Hand-Restoring Indicator. An indicator in which the moving part making the signal does not return automatically to its original position after the current actuating it has ceased.

Hand (Telephone) Set. See HAND MICRO-TELEPHONE.

Hand Winding. The insertion of a winding, turn by turn, by hand into the slots of a stator or rotor in cases where it is not possible or convenient to employ former wound coils.

Handle, Dead Man's. See DEAD MAN'S HANDLE.

Handle Type Fuse. A Fuse of the Bridge pattern in which the fuse carrier is provided with a handle by which it can be conveniently withdrawn.

Hanger. An insulating fitting by which an Ear carrying an overhead traction contact line is attached to a Bracket Arm or Span Wire.

Hanger: Bridge, Car-Shed, and Straight Line. See BRIDGE HANGER, CAR-SHED HANGER, etc.

Hanging Battsens or Hanging Lengths. Suspended rows of incandescent lamps used in stage lighting.

Hard Photo-Electric Cells. Photo-Electric Cells with a very high vacuum containing very few gaseous ions, less sensitive than soft cells, but more suitable for photometry.

Hard Tube. Vacuum tubes, such as "X" Ray tubes are said to be "hard" when the vacuum is very high. Hard "X" Ray tubes give more penetration than soft tubes. Cf. SOFT TUBE.

Hard Valve. A thermionic valve with a high vacuum in which there are therefore few gaseous ions, so that the discharge consists of a practically pure electron stream without gaseous ions. Cf. SOFT VALVE.

Hard "X" Rays. "X" Rays of great penetrative power, i.e. short wave lengths. The hardness of "X" Rays is sometimes referred to as "Quality." Cf. SOFT "X" RAYS.

"H" Armature. An armature with H-shaped core stampings with all the winding in the two slots so formed. Also known as *Shuttle Armature*; only used now in very small machines, magnetos, etc.

Harmonic. A component in the wave form of alternating currents, electric waves, etc., of a frequency which is a multiple of the fundamental frequency. The harmonic of twice the fundamental frequency is now commonly known as the second harmonic but was formerly called the first harmonic. Thus the triple frequency harmonic is now called the third harmonic, etc.

Harmonic Absorber. Apparatus used to absorb undesired harmonics in the wave form of currents in power circuits supplying transformers.

Harmonic Absorber, Static and Rotary. See STATIC HARMONIC ABSORBER and ROTARY ABSORBER.

Harmonic Amplifier. See STATIO FREQUENCY CHANGER.

Harmonic Analyser. An apparatus for determining the relative amplitudes of the constituent harmonics in a current or voltage wave form, etc.

Harmonic Detector. A voltmeter arranged in a special circuit so that it measures only the component of the frequency which is a harmonic of the fundamental, sometimes provided with a multi-way switch enabling the 3rd, 5th, etc., harmonics to be read separately.

Harmonic Filter. A combination of inductance and capacitance designed to eliminate any particular undesirable harmonic in the wave form in a circuit. (Also called *Harmonic Stopper*.) See also REJECTOR CIRCUIT.

Harmonic Interference. Interference in wireless telegraphy due to the presence of harmonics in the wave form of the transmitting oscillations.

Harmonic Power. The component of apparent power in the case of a non-sinusoidal wave due to harmonics only. Also called *Distortive Power*.

Harmonic Ringing. A method of *Selective or Party Line ringing* for telephone circuits in which the different bells connected to one line are adjusted so that each only responds to ringing currents of one frequency only.

Harmonic Selective Signalling. Signalling to one of a number of stations by a method similar to that described under *Harmonic Ringing*.

Harmonic Stopper. See HARMONIC FILTER.

Harp, Trolley. See TROLLEY HARP.

Hartley Circuit. A system for transmission of very short waves employing a *Dipole* aerial with extended antennae on both poles, consisting of two horizontal un-earthed sections in line with a single turn coil between them by which they are inductively coupled to the circuit of the oscillating valve.

Haulage (Electric). A system used in mines and elsewhere for hauling

trucks, etc., on level or inclined tracks, by ropes passing round pulleys and wound in by drums driven through suitable gearing by electric motors. Either an endless rope is employed with the motor running always in one direction, or the *Main and Tail* system in which the two ends of the rope are coiled in opposite direction of different parts of the drum, or on two coupled drums, and the motor is reversed to reverse the direction of motion of the trucks.

Head, Trolley. See TROLLEY HEAD.

Head Circuit. The circuit connected to the operator's *Head Receiver* in a telephone exchange.

Head End Loss (in a Loaded Submarine Cable). The difference between the attenuation at working current and its value at zero current due to the increased iron losses in the loading material.

Head Lamp. (1) A lamp with suitable reflectors, etc., to project light ahead of a car, locomotive, etc. (2) A lamp strapped to the forehead, used by surgeons, etc.

Head Phone, Head Receiver, or Head Set. The telephone receiver worn round the head by wireless telegraph and telephone operators.

Heart Shaped Diagram. See DIAGRAM OF RECEPTION.

Heat Coil. An apparatus used in telephone lines to afford protection from currents too weak to actuate ordinary fuses which nevertheless may be harmful when long continued; consisting of a coil of resistance wire, which if the leakage current passes for a sufficient time, becomes hot enough to melt a soldered connection and thus to break the circuit.

Heat Emissivity. The capacity of a conductor, the surface of a winding etc., for getting rid of heat (by radiation, convection, etc.), measured by the amount of heat omitted in unit time (expressed in watts per unit superficial area per degree of temperature difference).

Heat Meter (Electric). An apparatus for the electrical integration of the amount of heat supplied to a hot-water or steam-heating installation

In one form, an induction meter is so connected that the propelling torque is proportional to the resistance of the thermometer coils in the inlet and outlet pipes, and a rotary flow meter causes the integrating gear to be connected to the disc for a number of ten second periods in every five minutes proportional to the speed of flow.

Heater (Electric). An appliance wherein heat is produced where required by the passage of a current through a resistance; more particularly one arranged for heating rooms, etc. See RADIATOR, CONVECTOR, FIRE, RADIANT LAMP HEATER, PANEL HEATING, THERMAL STORAGE HEATING, ELECTRO-VAPOUR, RADIATOR and TUBULAR ELECTRIC HEATING SYSTEM.

Heater, Immersion. See IMMERSION HEATER.

Heating (Electric). The production of heat when and where required by means of an electric current, including more applications for industrial purposes than can be particularised here.

Heating, Panel, Plenum, Pyroelectric, and Thermal Storage. See PYRO-ELECTRIC HEATING, PLENUM HEATING, etc.

Heating Coefficient. A term sometimes used in connection with the predetermination of the temperature rise of electrical apparatus, for the temperature rise in degrees per watt dissipated per unit of radiating surface.

Heating Coil. A coil of high resistance wire used for producing heat when a current is passed through it.

Heating Element. A resistance employed for the production of heat by the passage of a current through it, complete with the carrier of refractory material with which it is mounted.

Heating Limit. See THERMAL LIMIT.

Heating Resistor. The actual resistance wire on other conductor producing heat on electrically-heated appliances. Cf. HEATING ELEMENT.

Heating Tests. Prolonged runs of electrical machinery, etc., at a

known load to ascertain that the specified limits of heating are not exceeded.

Heaviside Effect. See SKIN EFFECT.

Heaviside Layer. See KENNELLY-HEAVISIDE LAYER.

Heaviside Units. A system of electromagnetic units in which some of the units differ from those of the C.G.S. system by the factor 4π in order to simplify certain calculations.

Heavy Current Engineering. See ELECTRICAL ENGINEERING.

Heavy Glass (Faraday's). See FARADAY EFFECT.

Hecto-. Prefix meaning one hundred times.

Hecto-Ampere Balance. A Kelvin current balance with a range from 6 to 600 amperes.

Hedgehog Transformer. An old-fashioned type of transformer with an open magnetic circuit, composed of a bundle of iron wire with the ends spread out to reduce the reluctance of the return path of the lines through the air.

Heel (of a Brush). Properly the *Leaving Edge*, but often used for the *Entering Edge*.

Heeling Error. The error in a ship's compass due to the variation of the effect of the earth's magnetism as the ship rolls or "heels" over; compensated for by a group of permanent magnets set vertically. Cf. SEMICIRCULAR and QUADRANTAL ERRORS.

Hefner Candle. The German unit of luminous intensity; being the light given by the *Hefner Lamp* and having a value of 0.90 *International Candle*, under certain specified conditions.

Hefner Lamp. The German standard of luminous intensity; being a lamp of specified dimensions burning Amyl acetate. Cf. PENTANE LAMP.

Height: Radiation and Thermo-Electric. See RADIATION HEIGHT, and THERMO-ELECTRIC HEIGHT.

Heising Modulator. See CHOKER MODULATOR.

Helberger Furnace. See CRUCIBLE FURNACE.

Helion Filament. An incandescent

lamp filament composed of a carbon core with an outer coating of silicon.

Helium Valve. A rectifying valve consisting of a bulb containing helium at a low pressure, which is easily ionised, with suitable electrodes, the cathode having a small and the anode a large surface.

Hellesen Cell. A zinc-carbon *Dry Cell* with a depolariser of manganese dioxide.

Helmet. An iron cap or polepiece of an *Armed Lodestone*.

Helmholtz Formula. The following formula expressing the law of the rise of current in an inductive circuit with negligible capacitance: $i = (E/R) (1 - 1/e^{Rt/L})$ where i is the current t seconds after a circuit of resistance R and inductance L , containing an a.c.m.f., E , is closed and $e = 2.718$ (the base of Napierian logarithms).

Helmholtz Galvanometer. A form of *Tangent Galvanometer*, in which a particularly uniform field is produced by two widely separated coils on a common axis.

Hemitropic Armature Winding. See *HALF-COILED WINDING*.

Hemitropic Field. An alternator field system in which only alternate poles are provided with windings.

Henley Wiring System. A system of interior wiring employing either *Flat Twin* or *Earthed Concentric Cables*, without tubes or casing with special fittings for supporting, jointing, bonding and earthing.

Henry (H.). The practical unit of inductance named after the American physicist Joseph Henry (1797-1878), being 10^9 C.G.S. electromagnetic units. A coil with an inductance of 1 henry produces a flux of 10^9 lines per ampere turn. (Formerly called the *Secohm* or *Quadrant*.) Symbol: H .

Henrymeter. An instrument for direct measurement of inductance in which an alternating current from a hand-driven magneto generator is passed through the inductance to be tested, in series with a fixed inductance, and the potential difference across its terminals, sensibly proportional to its induc-

tance is read on a moving coil permanent magnet voltmeter working through a rectifying commutator driven off the same shaft as the alternator.

Heptode. A *Thermionic Valve* with seven electrodes, e.g. a transmitter amplifying valve for *Push-pull Connection*, in a single unit, provided with one filament, two anodes, two control grids and two stabilising grids. Used also as a frequency changer in super-heterodyne receivers.

Herseus Lamp. A form of mercury vapour lamp particularly rich in ultra-violet rays used for curative treatment.

Hering Furnace. A furnace in which the *Hering Pinch Effect* is relied on to produce circulation of the molten charge, by the use of auxiliary electrodes sunk in narrow tubes in the lining so that a high current density is produced in the portion of the charge therein.

Heroult Furnace. A form of direct current arc furnace used for aluminium reduction, etc., in which two arcs in series, between the respective vertical carbon electrodes and the charge, produce the initial heating and the reduction process is completed by the electrolytic action of the current passing through the molten charge. Another form of Heroult furnace has one vertical electrode and one in the hearth.

Hertz. A unit of frequency equal to one cycle per second, named after H. Hertz (1857-1894).

Hertz Oscillator. A system of conductors in which electrical oscillations can take place, consisting of two insulated plates, spheres, etc., with a spark gap between them, forming a condenser of very small capacity.

Hertz (or Hertzian) Waves. *Electric Waves* of much greater wavelength than light and including those as employed in wireless telegraphy, etc., so called because they were first experimentally observed by Hertz in 1888 although they had been theoretically predicted by Maxwell in 1864. Their wavelengths range from 0.01 to thousands

of metres, of which those above 0.1 metres can be employed for wireless communication.

Heterodyne. A term used both as a verb and as a noun in wireless telegraphy, etc., to signify producing *Beats* by the superposition upon received waves of oscillations from an independent source of slightly different frequency, either intentionally, as in *Heterodyne Reception*, or accidentally, owing to the interference of waves from another source of nearly equal wave-length. It is used as a noun both for the local oscillator producing the auxiliary oscillations and the interference caused by other stations in this way.

Heterodyne, Separate. See SEPARATE HETERODYNE.

Heterodyne Capacitance Bridge. An apparatus for comparing capacitances in which they are placed in oscillating circuits and a beat note produced of their combination; adjustment of the variable reference capacitance being made until a certain beat frequency as shown by a resonant indicator is attained.

Heterodyne Detector. A wireless receiver employing the *Heterodyne* system of *Reception*.

Heterodyne Filter. A filter consisting of condensers, and inductances, connected to the low frequency side of a receiving set with the object of by-passing audio-frequency oscillations caused by the heterodyning of the carrier wave of the station next in order of frequency from that being received.

Heterodyne Interference. Sounds heard in a wireless receiver due to beats produced by the superposition of waves from extraneous sources of nearly equal wave-length upon those sought to be received, including those caused by neighbouring receivers in a state of self-oscillation.

Heterodyne Oscillator. A separate oscillator for providing the local oscillations required for producing the intermediate frequency in *Superheterodyne Reception*.

Heterodyne Reception. The arrangement of thermionic valve circuits

for *Beat Reception* in which the local oscillations of slightly different frequency are provided by an independent source. Cf. ENDO-DYNE RECEPTION.

Heterodyne Wavemeter. A wavemeter employing the heterodyne principle to compare the waves to be measured with oscillations in a calibrated circuit.

Heterodyne Whistle. A steady note heard in a wireless receiving set due to beats formed by interference between stations of nearly equal wave-length.

Hetero-Galvanometer. A galvanometer for alternating current potentiometer and other testing of similar construction to a moving coil galvanometer for continuous current, receiving its current from a rectifying contact maker giving a frequency slightly less than that of the main current so that vibrations are produced corresponding to the difference in frequency.

Heteropolar Generator. The usual type of generator in which the armature conductors are alternately presented to opposite poles, as opposed to a *Homopolar* generator.

Heterostatic Method. A method of using a *Quadrant Electrometer* in which the needle is charged to a high potential independently of the quadrants. Cf. IDIOSTATIC METHOD.

Heurley Magnifier. See HOT-WIRE MAGNIFIER.

Heusler Alloys. Alloys showing marked ferro-magnetic properties containing manganese or manganese copper and one of the following ordinarily non-magnetic elements, viz., aluminium, tin, arsenic, antimony, bismuth or boron. Of these the aluminium-manganese bronzes show the strongest ferro-magnetic quality.

Hexaphase. Six-phase.

Hexode. A *Thermionic Valve* with six electrodes.

Hexode Multiplex. See MORSE MULTIPLEX SYSTEM.

Heyland Alternator. A self-exciting self-regulating alternator in which the field is excited through a commutator by a pair of transformers

connected across and in series with the armature respectively.

Heyland Diagram. A circle or vector diagram for showing the properties of induction motors.

Hibbert Cell. A standard cell similar to the *Clark Cell* but with an electrolyte of zinc chloride.

Hicks Hydrometer. A form of hydrometer for testing the condition of an accumulator cell, consisting of a glass tube containing a number of coloured glass loaded beads which float at different specific gravities of the electrolyte and show at a glance whether the cell is fully charged or not.

Hidden Conductors. Electric light wiring buried in the wall, etc., so as to be invisible. Cf. *SURFACE WIRING*.

High Definition Television. Television in which the number of scanning lines to the picture is over a hundred.

High Frequency Alternator. An alternator giving a sufficiently high frequency to be employed for maintaining oscillations for the production of electric waves for wireless telegraphy, etc. See *ALEXANDERSON* and *GOLDSCHMIDT ALTERNATORS*.

High Frequency Amplification. See *RADIO-FREQUENCY AMPLIFICATION*.

High Frequency Choke. See *AIR CORE CHOKES*.

High Frequency Currents. Currents at frequencies of the order of 10,000 cycles per second and over; employed in wireless telegraphy, in various forms of research work and for medical purposes. Their properties are considerably different from those of alternating currents at the usual frequencies of supply, for example ordinary conductors offer very much more resistance to their passage and they can be passed through the human body at pressures which would prove fatal at lower frequencies.

High Frequency Induction Furnace. A form of induction furnace chiefly used for metal smelting in which frequencies from 400 to 20,000 cycles per second are employed, e.g. the *Northrup Furnace*.

High Frequency Resistance. The increased resistance of a conductor to currents at high frequencies owing to the current being concentrated near the surface, and other causes including dielectric absorption and radiation. See *SKIN EFFECT*.

High Frequency Transformer. A transformer for high frequency currents, usually without an iron core. See also *AIR-CORE*, *OSCILLATION* and *TESLA TRANSFORMERS* and *JIGGER*.

High Frequency Treatment. Curative treatment involving the use of interrupted trains of damped high frequency oscillations. (Also called *D'Arsonvalism*.)

High Pass Filter. A *Wave Filter* which prevents the passage of oscillations below a certain frequency.

High Permeability Alloys. See *MU-METAL* and *PERMALLOY*.

High Power Choke Modulator. A *Chokes Modulator* in which the modulating valve controls the oscillator directly and handles a power equal to or greater than that in the last high frequency stage. Cf. *LOW POWER CHOKES MODULATION*.

High Power Station (Broadcasting). A station of considerable power, mainly intended for international communication.

High Pressure. The official Board of Trade description of a voltage between 650 and 3,000 volts between any two conductors or between one conductor and earth. Cf. *EXTRA HIGH PRESSURE*.

High Pressure Mercury Vapour Lamp. A high efficiency mercury vapour lamp in a tubular bulb of small dimensions; used for public lighting, etc., in which the bulb contains rare gases at a moderate pressure and a certain quantity of liquid mercury which vaporises after the initial discharge, facilitated by an auxiliary electrode, has started, and the tube has warmed up. The main bulb is surrounded by an outer bulb containing gas at a low pressure to maintain the necessarily high working temperature.

High Speed Circuit-Breaker. A

Circuit-Breaker designed to open after a very short interval after the attainment of the current for which it is set to prevent a short-circuit current reaching more than a small fraction of the value it would attain if not interrupted. For use particularly in preventing flashes-over in rotary converter substations for high voltages.

High Speed (Telegraph) Transmission. Telegraph transmission at speeds higher than are possible with keys manipulated by hand. See **WHEATSTONE AUTOMATIC**, **POLLAK-VIRAG WRITING TELEGRAPH**, etc.

High Tension. A general expression for high voltage without any definite limits; used particularly where distinction is to be made between systems or circuits of different voltage, and usually referring, in the case of wireless apparatus, to the voltage applied to the anode (plate) circuits of thermionic valves.

High Tension Battery. A term used in connection with wireless apparatus for a battery for supplying the anode (plate) circuits of thermionic valves, even when the pressure used would be characterised as low in other branches of electrical engineering.

High Tension Detonator. An obsolete form of detonator for electrical shot firing, in which the charge was fired by an electric spark.

High Tension Direct Current Railway. An electric railway employing a contact line pressure of over 1,000 volts (usually 2,500 to 3,000 volts), and direct current traction motors, usually coupled permanently in pairs in series. Enabling fewer substations to be used than with the pressures of up to 600 volts formerly general with direct current traction.

High Tension Ignition. Electric ignition systems for internal combustion engines in which a *Jump Spark* is produced within the cylinder by an induction coil and battery or by a *High Tension Magneto*.

High Tension Magneto. A magneto generator for ignition purposes with an induction coil complete with

condenser built into its armature giving a voltage high enough to produce sparks of the required intensity without further apparatus, combined with a contact-breaker to interrupt the primary circuit at the moment when the spark is required and a high tension distributor to connect the high tension winding of the coil to the sparking plugs of the different cylinders in rotation.

High Voltage. A comparative term employed generally for voltages high enough to require special precautions in dealing with them but without any definable limit.

High Voltage Test. Application of a higher voltage than that at which apparatus is designed to work to test the insulation.

Higher Harmonic Leakage. See **DIFFERENTIAL LEAKAGE**.

Highfield Booster. An automatic *Reversible Battery Booster* consisting of a generator, a motor and an excitor coupled together, the automatic regulation being produced by balancing the voltage of the excitor against that of the battery.

Hipernik. See **HYPERNIK**.

Hissing of an Arc. When the adjustment of the position of the carbons, or their shape, is incorrect, so that too heavy a current is produced for the size of the crater, a hissing sound is produced accompanied by movement and deformation of the arc (sometimes in U.S.A. called *Frying*).

Hittorf Tube. A form of *Cathode Ray Tube* with a concave cathode focusing the electron stream on to a platinum screen which becomes red hot when the tube is in use. Röntgen's discovery of "X" Rays was made with a tube of this kind.

Hochstädter Cable. A multicore high tension cable with a metallised paper covering or screen over the separate insulation of each core to control the distribution of potential in the dielectric.

Holden Permeability Bridge. A form of *Permeability Bridge*, in which the magnetising currents round the standard and sample bars are

varied until there is no magnetic leakage between the yokes by which they are joined as shown by a magnetometer between them. Cf. EWING PERMEABILITY BRIDGE.

Holder: Brush, Key, Lamp, and Valve. See BRUSH-HOLDER, KEY-HOLDER, etc.

Holding Wire (in Telephony). See "S"-WIRE.

Holding-on Coil. The winding of an electromagnet such as that in a no-voltage release, which holds the switch arm of a motor starter in the full on position against a spring unless the voltage fails, or the coil itself is short circuited by an overload or other trip gear.

Holophane Globes, Reflectors, Shades, etc. The trade name of a series of glass shades and reflectors constructed to diffuse or to concentrate the rays from incandescent lamps as required, by moulding the glass into a series of parallel prisms each giving total reflection at the correct angle. In some varieties the grooves forming the sides of these prisms are longitudinal on one side of the glass and transverse on the other.

Holtz Machine. An early form of *Influence Machine*, with one fixed and one moving plate. The former has two windows on the edge of each of which is an "armature" with a tongue terminating in one or more points. On the other side of the moving plate are comb collectors. There are no metallic carriers on the moving plate, and for starting an initial charge must be given to one of the armatures.

Home Office Fuses, Plugs, etc. Fuses, plugs, and other apparatus constructed in accordance with the recommendations of the Home Office, particularly as regards prevention of accidental contact with live parts and proximity of the hand to fuse wires which may blow on being replaced.

Home Office Switch. A term sometimes applied to *Shock-Proof* and *Earthed Switches*.

Homodyne Reception. A system of reception for *Suppressed Carrier* systems of wireless telephony in which oscillations of carrier fre-

quency are provided from separate source.

Homopolar Alternator. An alternator in which the variation of the flux through the armature winding is effected by a periodical presentation of poles of the same polarity and not by the passage of a series of alternate polarity; including some types of *Inductor Alternator*.

Homopolar Generator. A generator in which all the poles presented to the armature are of the same polarity. In direct current machines, usually with a single pole face to each pole, extending all round so that each armature conductor always cuts the lines in the same direction; sometimes called *Unipolar*, although strictly speaking there are still two poles, or *Non-polar* or *Acyclic*. See NOEGGERATH DYNAMO.

Honeycomb Coil. A coil wound to give a minimum of distributed capacitance with a maximum of inductance.

Hook Switch. A switch included in a subscriber's or other telephone instrument, which automatically makes the necessary changes in the connections from ringing to speaking conditions, when the receiver is taken off the hook; and, in the case of central battery working, actuates the relay controlling the calling lamp at the exchange by closing the speaking circuit.

Hopkinson Method of Iron Testing. A ballistic method of testing iron rods for permeability, in which the rod is so mounted in a yoke that it can be suddenly pulled out, causing the search coil to be freed and to be ejected by a spring so that it cuts the lines which previously passed through the specimen.

Hopkinson Test. A method of testing dynamos, etc., under full load conditions with only a small expenditure of power when two exactly similar machines are available. The two machines are coupled together so that one tends to drive the other as a motor, the second supplying the current for the purpose. To render this

possible it is only necessary to supply from an external source the power to make up for the losses in the two machines.

Horizontal Component. The component of the force exerted by the earth's magnetic field on a unit pole in a horizontal plane at any point on the earth's surface. Cf. VERTICAL COMPONENT.

Hormanence. A term proposed for *Reactive Volt-amperes*.

Horn (Electric). An instrument for producing a loud sustained note by throwing a column of air in an open tube into vibration by the movement of a diaphragm which is set into vibration by an electro-magnet with an action similar to that of the *Trembler* of an electric bell or by the teeth of a ratchet wheel driven by an electric motor striking a projection in the centre of the diaphragm, as in the Klaxon horn.

Horn : Arcing, Driving, Exponential, Logarithmic, and Pole. See ARCONG HORN, DRIVING HORN, etc.

Horn Arrester. A lightning or surge arrester in which the spark gap is provided with upwardly projecting diverging "horns" of thick wire up which the arc travels as soon as it is formed, until it reaches the wide part of the gap where it extinguishes itself by blow-out action of the current due to its self repulsion, assisted by the upward rush of heated air.

Horn Break Fuse or Switch. A switch or fuse fitted with *Arcing Horns*.

Horn Gap. A spark gap with divergent electrodes. See HORN ARRESTER.

Horse-Power. (H.P.). The practical unit of mechanical power. The British Horse-power is equal to 33,000 ft. lb. per hour or 746 watts. The metric Horse-power is 0.986 of this, being 75 kg.-metres per second.

Horse-Power, Electrical. (E.H.P.). A unit of electric power equivalent to the amount of power in one mechanical "horse-power," equal to 746 watts; sometimes convenient in calculating efficiencies of motors, etc.

Horse-Power Meter. A wattmeter calibrated to read direct in Electrical Horse Power or by assuming an efficiency, to give the output of a motor in Brake Horse-Power; or an ammeter graduated to do the same at an assumed constant voltage.

Horse-Shoe Filament. A carbon or other lamp filament forming a single half-turn without loops or zig-zags. Cf. LOOPED FILAMENT.

Horse-Shoe Magnet. A permanent or electro-magnet bent round into a form similar to that of a horse-shoe, but sometimes with the sides parallel, to bring the poles near together.

Horus, Bone of. See BONE OF HORUS.

Hospital Bus-Bars. An additional set of *Bus-Bars* provided for temporary or emergency purposes.

Hospital Switch. (1) A *Disabled Motor Switch* in a traction controller. (2) An automatic switch for changing over to an alternative source of supply when the current from the main source fails.

Hot Cathode. A cathode of an "X" Ray or other *Cathode Ray Tube* which is electrically heated to augment the disengagement of ions and electrons, i.e. to produce *Thermionic Emission*, with or without special oxides or other chemical substances to facilitate the action.

Hot Cathode Discharge Lamp. A form of *Discharge Lamp* in which a *Hot Cathode* is employed to increase its efficiency and to improve the distribution of light in the tube as well as to facilitate starting.

Hot Cathode Mercury Vapour Rectifying Valve. A *Thermionic Rectifier* in a bulb containing mercury vapour instead of a vacuum.

Hot Cathode Tube. See HOT CATHODE.

Hot Pad (Electric). An appliance for medical and hygienic purposes, consisting of a pad containing a special form of heating element by which a moderate amount of heat can be applied to any part of the body.

Hot Plate (Electric). See WARMING PLATE.

Hot Plate, Open Type. See OPEN TYPE HOT PLATE.

Hot-Water Radiator (Electric). A

pipe radiator in which circulates water heated within the apparatus by an immersion heater.

Hot-Wire Altitude-Meter. An instrument for measuring altitude by the reduction in cooling effect of the more rarefied air on an electrically-heated wire.

Hot-Wire Ammeter. See HOT-WIRE INSTRUMENTS.

Hot-Wire Anemometer. An instrument for measuring the velocity of an air current by its cooling effect on an electrically-heated wire; either by comparison of its resistance with that of a protected wire carrying the same current or by measurement of the current required to maintain a definite temperature.

Hot-Wire Arc-Lamp. A form of *Clutch Arc Lamp* in which the clutch is controlled by the expansion of a wire or strip of high resistance according to the current passing through it.

Hot-Wire Instruments. Current measuring instruments in which the current to be measured, or a known fraction thereof, passes through a fine wire which is thereby heated to an extent allowing of its expansion or sag to be used to deflect a pointer or mirror through appropriate mechanism, suitable either for alternating or direct current. Also called *Thermo-expansion Instruments*. Cf. ELECTROMAGNETIC, MOVING COIL, and INDUCTION INSTRUMENTS.

Hot-Wire Magnifier (Hourley's). An instrument for increasing the strength of signals received over submarine cables in which a moving coil (similar to that in a siphon recorder) causes an electrically heated platinum wire to alter its position relatively to two fixed wires, thereby changing their relative resistances and upsetting the balance of a Wheatstone's Bridge.

Hot-Wire Oscillograph. An oscillograph such as that of Irwin, in which the mirror is deflected in accordance with the difference in the expansion of two fine wires carrying currents proportional respectively to the sum and the

difference of the current to be measured (c) and a constant current (k). The deflection is then proportional to $(c + k)^2 - (c - k)^2 = 4ck$.

Hot-Wire Telephone. See THERMAL TELEPHONE.

Hot-Wire Voltmeter. See HOT-WIRE INSTRUMENTS and CARDEW VOLT-METER.

Hot-Wire Wattmeter. An instrument in which a mirror is deflected in accordance with the difference in the expansion of two fine wires which carry currents proportional to the sum and difference respectively of the main voltage (E) and current (I). The deflection is then proportional to $(E + I)^2 - (E - I)^2 = 4EI$, which is proportional to the watts.

Hour-Meter. A meter registering the time in hours during which an intermittently used circuit has been closed irrespective of the strength of the current. Also called *Time-Meter*.

Hourly Rating. See ONE-HOUR RATING.

House Service. See SERVICE CABLE.

House Service Meter. An integrating meter for measuring the consumption in a house installation.

House Transformer System. A system of alternating current distribution now practically obsolete, in which high tension distributing mains are employed with separate transformers on the premises of every consumer to reduce to a voltage suitable for incandescent lamps.

Housing. The *Stator Frame* of such a machine as an alternator or an induction motor.

Howard Protective System. A system of leakage protection of a.c. machines, etc., by earthing the frame through a current transformer which actuates a tripping relay if a current flows to earth.

Howl. See SING.

Howler. Any apparatus for producing an oscillating current of fixed or variable audio-frequency such as that sometimes employed in telephone exchanges to pass such a current into a subscriber's line if his receiver is left off the hook, in order to make it give out a

sound audible from some distance to call attention to the fact.

Howling. If a telephone receiver is placed face to face with the transmitter, connected up in the usual way, a continuous sound or "howling" is produced by a cumulative effect setting up oscillations of a frequency dependant upon the electrical constants of the circuit as well as the mechanical constants of the diaphragm. A similar effect sometimes occurs in wireless *Loud Speakers* when the natural frequency of the diaphragm coincides with that of the filament of an amplifying valve by an action analogous to *Microphonic Noise*. The term is applied rather indiscriminately to accidental loud continuous noises in wireless receivers, due to oscillations in radio-frequency or audio-frequency circuits. See also *SING*.

Hozier-Brown Detector. An electrolytic detector consisting of a pellet of lead oxide between lead and platinum electrodes.

H.P. The usual abbreviation for *Horse-Power*.

"H" Pole. A support for overhead lines made by two parallel wooden poles braced together. Cf. **"A" Pole**.

H.T. The usual abbreviation for *High Tension*.

Hughes Induction Balance. An instrument in which two secondary coils are connected in opposition with each other in series with a telephone receiver. The primary coils to which these are inductively coupled are in series with a microphone, or source of vibratory currents. If the mutual induction of the two pairs of coils is exactly the same, no sound is produced in the telephone, but if there is the slightest inequality, due, for example, to the presence of a mass of metal near one of them, the balance is upset and a sound is heard. The apparatus can thus be used to ascertain the presence of bullets, etc.

Hughes Printing Telegraph System.

A type printing telegraph system which has been widely used on cables of short length, etc., depend-

ing upon synchronously revolving selectors at either end. These cause a current to be sent at that part of the cycle of operations when the receiving selector arm is in the position corresponding to the letter to be printed. The type-wheel is thus stopped at the correct position. In the sending apparatus the depression of one of a number of keys raises a contact piece which touches the selector arm as it comes round.

Hummer. An instrument used in the Navy, etc., for giving a call signal by the vibration of a diaphragm actuated by a reed in connection with an alternating current electromagnet.

Humming. Alternating apparatus frequently gives out a musical note corresponding to the frequency of the current, especially in the case of transformers, etc., when parts of the core are loose. In like manner not only can an arc give out a note corresponding to the frequency if fed by alternating currents, but if connected across an oscillating circuit can give out the note of the frequency of the superposed oscillations. See **DUPPEL ARC**. Humming from quite another cause is also noticed in telephone wires, etc., but this is purely a mechanical effect due to the natural period of vibration of the span. Various devices are employed to prevent this. See **SILENCERS**.

Hundreds Selector (in Automatic Telephony). A selector responding to the impulses representing the second digit of a four figure number dialled in a call, the function of which is to make contact between a *Thousands Selector* and an appropriate *Final Selector*.

Hunting. (1) Just as the governor of an engine is said to "hunt" when it allows of periodic fluctuation of the speed above and below the normal, so this term can be applied to a similar oscillation of frequency between alternators which have been put in parallel. These, when excessive, may produce serious circulating currents and electrical disturbance. (2) In automatic telephony, the automatic action of

a selector arranged to search for and establish connection with an idle line or link in a group.

Hydro-Electric Generating Set. A generator driven by a water turbine, usually direct coupled to a vertical or horizontal shaft.

Hydro-Electric Generating Station. A generating station in which the generators are driven by water power.

Hydro-Electric Machine. An old form of experimental apparatus in which static electricity was produced by the friction of steam issuing from a nozzle.

Hydro-Electric Power Station. See HYDRO-ELECTRIC GENERATING STATION.

Hydrogen Cooling. Cooling of electrical machinery, etc., by a current of hydrogen instead of air, permitting of higher output for the same temperature use, with much reduced windage and other advantages.

Hydrogen Electrode. A *Normal Electrode* formed by occluded hydrogen in a base of spongy platinum or some such substance.

Hydrogen Welding, Atomic. See ATOMIC HYDROGEN WELDING.

Hydrometer. A float, usually in the form of a glass bulb with a graduated stem weighted to float upright, showing by its depth of immersion the specific gravity of the liquid in which it is placed. Used to ascertain the state of charge of an accumulator cell by testing the specific gravity of the electrolytic. See also ACIDOMETER.

Hydrometer, Hicks. See HICKS HYDROMETER.

Hydrophone. An arrangement of submerged microphones for detecting the proximity of submarines or other craft.

Hyperdyne Reception. A system of wireless reception similar to the earlier forms of *Superheterodyne Reception*, but employing a higher intermediate frequency (about 2000 kc.), with *Screen Grid Amplifiers*.

Hyperheterodyne Reception. See HYPERDYNE RECEPTION.

Hypermik. A 50 per cent iron-nickel alloy of high permeability and low

hysteresis at low inductions, suitable for cores of instrument transformers.

Hysteresigraph. An instrument for automatically tracing hysteresis curves.

Hysteresimeter (Blondel). An instrument for testing the magnetic quality of iron, in one form of which a packet of annular stampings of the material to be tested is placed in a spring controlled pivoted holder in the field of a rotating magnet and the force tending to draw the sample round is measured by the deflection of the spring. Cf. HYSTERESIS TESTER (Ewing).

Hysteresis. A word describing the irreversibility of the relation between two quantities, which is seen by the effect being different according to whether the magnitude of the cause is increasing or decreasing; as in the relation between magnetising force and induction in iron, which has the effect of making the latter lag, so to speak, behind the former in its changes. Hence the name which was derived by Ewing from a Greek word meaning to lag. Owing to this effect an expenditure of energy is required to carry the induction round a closed cycle of reversal and this energy is measured by the area of the loop enclosed by the *B-H* curve for the enclosed cycle. The word "hysteresis" is also used for the amount of the energy expended in this way, and is thus a measure of the suitability of iron or steel for transformers and other electrical purposes. This is more properly called *Hysteresis Loss*. It can be expressed in watts per lb. of the material at a definite frequency, or in ergs per cubic centimetre per cycle. See also DIELECTRIC HYSTERESIS.

Hysteresis: Dielectric, Elliptic, Linear, Magnetic, Rotary, Static, and Viscous. See DIELECTRIC HYSTERESIS, ELLIPTIC HYSTERESIS, etc.

Hysteresis Coefficient. See STEINMETZ COEFFICIENT.

Hysteresis Curve. A *B-H* curve taken with a gradual progressive rise and fall of the magnetising

force in both directions successively to show the area between the rising and falling curves, i.e. the *Hysteresis Loss*. Cf. REVERSAL CURVE.

Hysteresis Error. The difference between the readings of an ammeter, etc., containing iron, on a rising and a falling current of the same value.

Hysteresis Loop. See HYSTERESIS CURVE and HYSTERESIS.

Hysteresis Loss. See HYSTERESIS.

Hysteresis Tester (Ewing). An instrument designed by Ewing for the direct measurement of *Hysteresis* in samples consisting of small bundles of sheet steel, iron, etc.

One of these is rotated between the poles of a pivoted permanent magnet, and the deflection due to the torque between the magnet and the specimen against a gravity control is measured. The scale is calibrated by standard samples of which the hysteresis has been measured independently.

Hysteresis Tester, Epstein. See EPSTEIN HYSTERESIS TESTER.

Hysteretic Constant. See STEINMETZ COEFFICIENT.

Hysteretic Index. The index of the power to which the induction must be raised to be proportional to the hysteresis loss. See STEINMETZ COEFFICIENT.

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I. Symbol for *Current*: also *Luminous Intensity*.

Ice-Pail Experiment (Faraday's). See FARADAY'S "ICE-PAIL" EXPERIMENT.

Iconoscope. The "electric eye" used in the transmitter of one form of television apparatus, in which an image is produced by a camera lens upon an insulating screen within a vacuum tube covered with a mosaic of separate deposits of photo-electrically active material, forming, in connection with the back plate, a series of light-sensitive cells. An electrostatically focused electron beam is caused by suitable deflecting coils to scan the screen in parallel lines, and as it falls on each cell it releases the charge produced by the light falling on it, and sends, through amplifiers and the transmitting apparatus, a series of signals of intensity depending upon the illumination of the object before the camera. See also KINESCOPE.

Idiostatic Method. A method of using a *Quadrant Electrometer*, in which the pressure to be measured is applied between the needle and one pair of quadrants. Cf. HETEROSTATIC METHOD.

Idle Component of Current, Voltage, etc. See REACTIVE CURRENT, VOLTAGE, etc.

Idle Current. See REACTIVE CURRENT.

Idle Current Wattmeter. A wattmeter with a highly inductive pressure coil measuring $EI \sin \phi$ (instead of $EI \cos \phi$), i.e. the reactive component of the volt-amperes.

Idle Wire. The portion of an armature winding, such as the end connections, etc., which does not actually cut the lines of force.

Idometer. An instrument for measuring the uniformity of manufactured products. Rubber sheet, for example, is passed between the plates of a condenser, the changes

in capacitance of which are observed by a delicate bridge method.

Ignition (Electrical). (1) The firing of an explosive mixture of gases or vapours by an electric spark; either accidentally, as in explosions in collieries due to faulty electrical apparatus where open sparking takes place, or in internal combustion engines, where the charge is fired at the right part of the stroke electrically. The spark within the cylinder may be produced by an *Induction Coil*, or by mechanically breaking an inductive circuit, or, more usually, by a magneto generator, itself containing an induction coil, in combination with suitable current timing apparatus. (2) In a mercury vapour rectifier, the striking of an auxiliary arc to start the main arc. See MAGNETO, etc.

Ignition: Battery, Coil, Dual, High Tension, Low Tension, and Magneto. See BATTERY IGNITION, COIL IGNITION, etc.

Ignition Plug. See SPARKING PLUG.

Ignition Rating. The rated ampere-hour capacity of small accumulators used for ignition apparatus on a basis of intermittent working. Usually twice the continuous rating at a low discharge rate.

Ignition Voltage. The voltage required to start the arc in a mercury vapour rectifier, etc.

Ignitron. A mercury vapour tube in which the time of formation of the arc is controlled by an auxiliary electrode of carborundum or similar material from which a spark passes to the mercury when a certain potential is attained between them.

Ikeda Test. A fatigue test for metals, in which the condition of the material is gauged by the measurement of the changed electrical resistance.

Ikonophone. An experimental apparatus combining *Television* by

line currents with telephony to render the distant speaker's face "visible."

Ignor System. A system of power equalisation, employed in cases of very variable load, such as winding plant for deep mineshafts, electrically driven rolling mills, etc., to protect the generating station from excessive peaks in the load, in which power is supplied to the working motor through a motor-generator with a heavy flywheel. The control is such that the flywheel is allowed to slow down and give out its stored energy at times of heavy demand and to regain its speed by drawing power from the generating plant when the load is light. See *SLIP REGULATOR*, etc.

Illuminance. A term proposed in preference to *Illumination* for its quantitative expression.

Illuminated Diagram. A diagram, in a signal box, of a portion of a railway usually containing crossings or points in which each section is normally illuminated from behind by a lamp arranged to become extinguished whenever there is a train on that section of the line.

Illuminated Dial Instruments. *Measuring Instruments* for switchboard use in which translucent dials are used, illuminated from behind.

Illumination. The total amount of *Luminous Flux* (lumens) falling on a surface per unit area, i.e. the density of the luminous flux at the point in question. Several units have been employed for its measurement, viz. (1) the *Lux*, one lumen per square metre; the *Phot*, one lumen per square centimetre; and the *Foot-Candle* one lumen per square foot (or the illumination produced by one candle at a distance of one foot). One foot-candle is equivalent to 10.746 lux. Symbol: *E*.

Illumination: Direct, Indirect and Semi-Indirect. See *DIRECT ILLUMINATION*, *INDIRECT ILLUMINATION*, etc.

Illumination Photometer. An instrument which measures the actual value of illumination at any point

in a building, in the street, etc. Usually of a portable nature, and depending upon comparisons between a screen receiving the illumination to be measured and a second screen illuminated to a variable extent by a standard lamp within the instrument by tilting the screen or partly obstructing the light. See also *FOOT-CANDLE METER*, *ILLUMINOMETER*, *LIGHT-METER*, *LUMETER*, *LUXMETER*, *LUXOMETER*, *SHARP AND MILLER PHOTOMETER*, *TROTTER PHOTOMETER*, and *WEBER PHOTOMETER*.

Illuminometer. A name given to some forms of *Illumination Photometer*, particularly to those on the Lummer-Brodhun principle. Also known as *Macbeth Illuminometer*.

Image (Electrical). A charge or system of charges, imagined for the sake of convenience in calculating the distribution of charge on a surface, situated on one side of that surface, which would produce on the other side the same effect as the actual electrification of the surface.

Image Tube, Electron. See *ELECTRON IMAGE TUBE*.

Imbricated Winding. A form of stator winding for turbo-alternators, etc., in which the end connections instead of being disposed in separate ranges overlap one another (like tiles on a roof), and can be clamped down together.

Immersed Rheostat. A resistance for artificial loads, etc., composed of bare wire immersed in water allowed to boil.

Immersible Motor, Switchgear, etc. A motor, switchgear, etc., constructed to work under water.

Immersion Heater. A self-contained apparatus with a heating resistance and the necessary connections which can be immersed in a liquid which it is desired to heat; useful for heating small quantities of water for domestic purposes, etc.

Impedance. The property of a circuit, depending upon frequency, inductance, capacitance and resistance, which determines the current produced by a given alternating voltage in that circuit, i.e. the

ratio of the root-mean-square voltage to the r.m.s. current. Impedance, like resistance, is measured in ohms and its value for a circuit of resistance R ohms, inductance L henries, and capacitance C farads (not microfarads) at a frequency of f cycles per second, is $\sqrt{[R^2 + (2\pi fL - 1/2\pi fC)^2]}$, formerly sometimes called *Apparent Resistance*. Symbol: Z .

Impedance: Aerial Feed, Anode, Apparent, Characteristic, Driving Point, Internal Line, Mutual, Oscillatory, Plate, Synchronous, and Terminal. See AERIAL FEED IMPEDANCE, ANODE IMPEDANCE, etc.

Impedance Bond. A rail bond of low resistance but high inductance used on traction systems with continuous current return through the running rails and alternating current track circuit signalling, at points where it is required to prevent the signalling current from passing without obstructing the traction return current.

Impedance Bridge. A *Wheatstone's Bridge* method of measuring the combined resistance and inductance of a telephone receiver, etc., in which the current supply is alternating, of audio-frequency; a telephone is used in place of a galvanometer, and the instrument under test is compared with known variable resistances and inductances in the opposite bridge arm; a balance being obtained by adjusting both until there is no sound in the bridge telephone.

Impedance Coil. See CHOKING COIL.

Impedance Drop. That part of the *Voltage Drop* in a circuit, apparatus, etc., due to *Impedance*.

Impedance Factor. A term sometimes used for the ratio of the *Impedance* of a circuit to its *Resistance*.

Impedance Relay. See DISTANCE RELAY.

Impedance Rise. A rise in voltage due to the impedance of a circuit apparatus, etc., when the conditions are such as to produce a leading current.

Impedance Triangle. A graphic illustration of the relations of the pro-

perties of a.c. circuit, consisting of a right-angled triangle, the sides of which enclosing the right angle are proportional to the resistance and reactance respectively, while the hypotenuse represents the impedance of the circuit, and the cosine of the angle between the sides representing resistance and inductance is the power-factor of the circuit.

Impedance Voltage. The vectorial sum of the *Resistance Voltage* and the *Reactance Voltage*.

Impeder. A coil, with or without an iron core, with considerable impedance introduced into the circuit for that reason.

Imperfect Magnetic Circuit. A magnetic circuit in which there is considerable leakage of the lines of force, outside the iron, etc.

Impregnated Carbons. Carbons for use in flame arc lamps, impregnated with chemical substances, usually for the purpose of imparting luminosity of a distinctive colour to the arc itself.

Impregnated Insulating Materials. Fibrous materials, such as cloth or paper, impregnated with oily or resinous substance, etc., from which most of the insulating and moisture-proof quality of the resulting material is derived. See EMPIRE CLOTH, VARNISHED CAMBRIC, PAPER INSULATED CABLES, and CLASS A INSULATING MATERIALS.

Impregnating Material. A composition similar to an *Insulating Varnish* used to render fibrous materials insulating, moisture-proof, and durable.

Impregnation, Vacuum. See VACUUM IMPREGNATION.

Impressed E.M.F. or Voltage. The e.m.f. applied to a part of a circuit in which there is a *Back E.M.F.*; the current produced depending upon the resultant or *Effective E.M.F.* (Also called *Applied E.M.F. or Voltage*.)

Impulse. A term used particularly in automatic telephony for a well defined change of current of brief duration, e.g. a flow of current or a cessation of current for a short period.

Impulse, Break and Make. See **BREAK IMPULSE** and **MAKE IMPULSE**.

Impulse Action (in Automatic Telephony). The action of a *Selector* in making connection with a desired line under the control of the calling impulses. Cf. **FINDING** and **HUNTING**.

Impulse Circuit. (1) A circuit in automatic telephone systems used only for the transmission of current *Impulses*, e.g. for calling signals and not telephone currents. (2) A circuit, built up of condensers, resistors, and spark-gaps to produce a sudden high voltage for insulator testing, etc., on the sparking over of the first or trigger spark-gap of the series.

Impulse Circuit-Breaker. A class of high voltage multi-break circuit-breaker with mechanical oil-blast.

Impulse-Driven (Electric) Clock. A clock in which the hands are driven forward in steps by current impulses controlled by a master clock.

Impulse Excitation. The methods of starting oscillations in the aerial circuit of a wireless telegraph transmitting apparatus by a sudden voltage surge and not by applied oscillations of the frequency of the aerial circuit; also called *Shock Excitation*.

Impulse Frequency. The number of impulses occurring per second.

Impulse Generator. See **SURGE GENERATOR**.

Impulse Machine (in Automatic Telephony). An apparatus for sending impulses.

Impulse Period. The time elapsing between the commencements of succeeding regular impulses.

Impulse Radiation. A term sometimes used for the "X" Rays of continuous spectrum given off by the anticathode of an "X" Ray Tube, in addition to those of frequencies corresponding to the line spectrum of the material of the anticathode. Cf. **SPONTANEOUS RADIATION**.

Impulse Ratio. The ratio of the time of duration of an impulse to the *Impulse Period*.

Impulse Repeater (in Automatic Telephony). An appliance for re-

peating calling impulses in another circuit.

Impulse Spark-Over Test. A spark-over test of an insulator with a suddenly applied or oscillatory voltage, usually giving a higher spark-over voltage than with a steady test voltage.

Impulse Spring. A contact spring employed to control impulses in automatic telephony.

Impulse Summator. See **SUMMATOR**.

In Bridge. An expression used in telephone engineering to signify in parallel.

In Opposition. Windings, cells, etc., are said to be "in opposition" when connected in such a direction that their effects tend to neutralise each other.

In Phase. Two alternating currents, voltages, oscillations, etc., are said to be "in phase" when their wave-forms are of the same shape and vanish at the same instants. (Cf. **IN STEP**.)

In Step. Two alternating currents, voltages, oscillations, etc., are said to be "in step" when they vanish at the same instants. (Cf. **IN PHASE**.)

Incandescence Lamp. An expression preferred by some writers to *Incandescent Lamp*.

Incandescent (Electric) Lamp. An electric lamp in which the light is given out from a filament or wire heated to incandescence by an electric current; also called *Filament Lamp* and *Glow Lamp*. See **CARBON LAMP**, **METAL FILAMENT LAMP**, **GAS FILLED LAMP**, etc.

Incandescent Lamps, Blackening of. See **BLACKENING OF INCANDESCENT LAMPS**.

Incandescent Lighting. Interior or exterior lighting by electric *Incandescent Lamps* (introduced about 1880).

Inching Starter. A motor starter in which very slow movement can be obtained on the lowest step for moving the machinery forward inch by inch, e.g. in rotary printing machines for threading the paper in.

Inclination. See **DIP**.

Inclinatorium. See **DIPPING NEEDLE**.

Inclined Carbon Arc Lamp. An arc

lamp in which the carbons are not set in line, but arranged at an angle, as in the V position adopted in most flame arc lamps, or set at an angle of about 120° with the positive carbon horizontal as in some projector lamps.

Inclined Catenary Suspension. *Catenary Suspension* in which the points of support of the catenary are on either side of the track centre alternating except on curves, where inclined droppers are used.

Inclinometer. See *DIPPING NEEDLE*.

Incoming Feeder. A feeder connected to substations, consumers' premises, etc., through which a supply of energy is received. Cf. *OUTGOING FEEDERS*.

Increment Iron Losses. A term used to include the portion of the iron losses in a.c. machines due to flux changes of frequencies higher than the fundamental.

Increment Key. A key employed in *Quadruplex* telegraphy which sends signals by varying the strength of a current but does not reverse it. Cf. *REVERSING KEY*.

Incrementer or Incrementer Relay. An apparatus used in *Quadruplex* repeating stations to perform the functions of a remote controlled *Increment Key*.

Independent Axle Drive (of Electric Locomotives). A system of drive in which the motors are connected to the driving wheels by outside gearing and flexible linkage, avoiding the springs of *Quill Drive* and the heavy reciprocating parts of *Side Rod Drive*.

Independent Drive (in Wireless Transmitters). An arrangement for ensuring constancy of wavelength (independently of variation of capacitance of the aerial, etc.), consisting of an auxiliary oscillating circuit or *Master Oscillator* coupled to the grid of the main oscillation generator, to control its frequency. (Also called *Master Drive*.) See also *TUNING FORK CONTROL*, *CRYSTAL CONTROL*, and *VALVE DRIVE*.

Independent Feeder. A *Feeder* used only for supplying energy to a point from one source of supply. (Also

called *Radial Feeder* and *Dead-Ended Feeder*.) Cf. *INTERCONNECTING FEEDER*.

Independent Time Lag, etc. See *DEFINITE TIME LAG, etc.*

Independent Trip. A *Tripping Device* actuated by an auxiliary source of supply independent of the main circuit. Cf. *DIRECT TRIP*.

Independent Unit. An arbitrarily chosen unit of a quantity such as length, mass, or time, entirely unrelated to any other. See also *FUNDAMENTAL UNITS*.

Index, Hysteretic. See *HYSTERETIC INDEX*.

India-Rubber Cable, Wire, etc. Cable or wire insulated with one or more layers of pure or vulcanised india-rubber; with or without a further protective covering of other materials.

India-Rubber Gloves. Insulating gloves of india-rubber worn when handling live conductors.

Indicating Instruments. Measuring instruments by which the value of the current, etc., or other quantity to be measured is indicated visually at the time of the observation by a pointer on a scale or an equivalent device. Cf. *INTEGRATING INSTRUMENTS* and *GRAPHIC INSTRUMENTS*.

Indicator. (1) Some form of *Indicating Instrument*. (2) An electromagnetic signalling device to indicate which of a number of circuits has been used to make a call signal. (3) A pressure recorder for steam or internal combustion engines. A recent electrical form for very high speed engines depends upon the change of capacitance between two discs, one of which is deformed by the pressure.

Indicator: Call, Current, Demand, Direction, Eyeball, Form-Factor, Frequency, Hand-Restoring, Leakage, Limit, Maximum Demand, Phase, Phase Sequence, Piezo-electric, Polarity, Pole, Position, Potential, Power-Factor, Revolution, Self-Restoring, and Speed. See *CALL INDICATOR*, *CURRENT INDICATOR*, etc.

Indicator Drop. An indicator in the form of a hinged flap normally held up by a catch which is released by

an electromagnet to allow the flap to drop when a signal is made.

Indirect Arc Furnace. An *Arc Furnace* in which the arc occurs only between the electrodes and not between an electrode and the charge. Cf. **DIRECT ARC FURNACE.**

Indirect Fittings. Fittings provided with opaque reflectors for indirect lighting.

Indirect Illumination or Lighting.

Lighting in which the lamps are entirely hidden and the light therefrom is directed to the ceiling, etc., from whence it reaches the area to be illuminated by diffused reflection. Cf. **DIRECT LIGHTING, SEMI-INDIRECT LIGHTING, etc.**

Indirect Rays (in Wireless Transmission). That part of the radiation which makes a considerable angle with the ground and only reaches the receiving station by downward reflection or refraction from the *Ionosphere*. Such rays are subject to *Fading*, and are more readily received in darkness. Distant stations are almost entirely heard by this means. (Also called *Space Rays*.) Cf. **DIRECT RAYS.**

Indirectly Heated Cathode. A cathode in a thermionic valve consisting of a plate coated with a special material and as barium oxide heated by radiation from an independent filament which may be heated by alternating current.

Indirectly Heated Valve. A thermionic valve with an *Indirectly Heated Cathode*.

Individual Drive. Electric driving in a factory, etc., where a separate motor is used to each machine. Cf. **GROUP DRIVE.**

Individual (Telephone) Line. See **DIRECT LINE.**

Individual Axle Drive. See **INDEPENDENT AXLE DRIVE.**

Induced Charge. A charge produced in a conductor by the action through a dielectric, of a neighbouring charge of opposite sign.

Induced Current. A current produced in a circuit by an e.m.f. due to a change in the magnetic flux linking the circuit, e.g. by its movement relatively to a magnetic field, or a change in a current in a neighbouring circuit.

Induced E.M.F. See **INDUCED CURRENT.**

Induced Needle. A term sometimes used in telegraphy for a soft iron "needle" in a *Single Needle Receiver*, in which the required polarity is maintained by the field of fixed permanent magnets to prevent accidental reversal of polarity or gradual weakening due to the current in the coils.

Induced Ventilation. Ventilation of a machine or apparatus by air drawn through it by exterior fans, etc. Cf. **FORCED VENTILATION.**

Inductance. The property of a circuit in virtue of which a change of current therein produces a change in the flux exchange in that circuit (*Self-Inductance*) or in a neighbouring circuit (*Mutual Inductance*). Thus in a circuit possessing self-inductance, a current takes time to establish itself or to die out owing to the e.m.f. opposing the change induced by the change of magnetic flux due to the current itself; analogous to inertia. One of the most important effects of inductance is to cause an alternating current to lag in phase behind the e.m.f. producing it. A coil possessing self-inductance, i.e. a coil so wound that a current in it produces a magnetic flux linking the circuit is often spoken of simply as "an inductance," but the term *Inductor* is preferable. The practical unit of inductance is the *Henry* which is 10^9 C.G.S. electromagnetic units, and is the inductance in which one volt is induced by a variation of current at the rate of one ampere per second. Usual symbol: *L*.

Inductance: Apparent, Distributed, Mutual, Self, and Variable. See **APPARENT INDUCTANCE, DISTRIBUTED INDUCTANCE, MUTUAL INDUCTANCE, etc.**

Inductance Coil. A coil possessing considerable inductance compared with resistance or self-capacitance such as the plug in coils used in the older wireless receiving sets.

Inductance Drop. That part of the voltage drop along an alternating current transmission line, or in a

transformer, etc., due to the *Inductance* of the line or apparatus.

Inductance Factor. A term occasionally used for the ratio of the wattless current to the total current in an alternating current circuit, i.e. the sine of the angle of lag. Cf. **POWER FACTOR**.

Induction. (1) The act of inducing charges, magnetisation or currents. See **INDUCED CHARGE** and **INDUCED CURRENT**. (2) *Flux Density*. (3) *Inductive Interference* in Telegraph and Telephone circuits, etc.

Induction: Electromagnetic, Electrostatic, Magnetic, Mutual, and Self. See **ELECTROMAGNETIC INDUCTION**, **ELECTROSTATIC INDUCTION**, etc.

Induction Balance. See **HUGHES INDUCTION BALANCE**.

Induction Coil. (1) A coil with a primary winding of comparatively few turns of thick wire and a secondary of many turns of fine wire, used to obtain an intermittent high voltage in the secondary winding by supplying an intermittent current to the primary coil. The primary current is broken by an *Interrupter* and the sharper the break the greater is the rate of change of the primary current and therefore the secondary voltage produced. Sufficiently high voltages are obtainable to give long spark discharges in air. Induction Coils are used in the simpler forms of wireless telegraph transmitters, to excite *Röntgen Ray* and other *Vacuum Tubes*, and for electromedical purposes, and for *Electric Ignition*. (2) A form of transformer used in telephone speaking circuits is also called an Induction Coil. This is used to convert the fluctuating but unidirectional current of the microphone circuit into an alternating current which gives better effects in the receiver.

Induction Compass. See **EARTH INDUCTOR COMPASS**.

Induction Density. See **FLUX DENSITY**.

Induction Disc Motor. A type of small a.c. motor used for driving gramophones, etc., similar to the

movement of an induction meter. The rotor consists of a disc in which eddy currents are induced by a.c. magnets.

Induction Furnace. A form of electric furnace in which the heating effect is due to currents induced in the mass of the charge by a primary coil carrying an alternating current.

Induction Generator. A machine similar in construction to an *Induction Motor* run above synchronous speed as a generator, when it can contribute power to the system at any fixed frequency within a certain range of speed variation.

Induction Instruments. Measuring instruments for alternating currents in which the torque is produced by the action of a rotating field on a metal disc or drum not connected to the circuit, on the same principle as the induction motor. In the case of single-phase instruments the rotating field is produced by a *Phase-Splitting Device*.

Induction Lamp. See **NEON INDUCTION LAMP**.

Induction Machine. A name sometimes given to *Influence Machines*.

Induction Meter. See **INDUCTION INSTRUMENTS**.

Induction Motor. An alternating current motor in which the stator only is connected to the external circuit in such a manner as to produce a rotating field. The rotor acts like the secondary of a *Transformer*, and the currents induced therein cause it to follow the rotating field and to run with a speed slightly below that of the field. The stator is usually fed by polyphase currents, but single-phase induction motors are also used with special arrangements for producing the rotating field at starting. Induction motors are either provided with slip-rings by which a resistance can be inserted in each phase of the rotor winding for starting or to provide a certain amount or speed regulation, or are of the *Squirrel Cage* type with a permanently short-circuited rotor winding. See **SLIP**.

Induction Motor: Single Phase, Slip-

Ring, Squirrel-Cage, Synchronised, and Synchronous. See SINGLE-PHASE INDUCTION MOTOR, SLIP-RING INDUCTION MOTOR, etc.

Induction Motor-Generator. A Motor-Generator driven by an induction motor.

Induction or Inductance (Voltage) Regulator. A term formerly used for various forms of voltage regulator for alternating current circuits, in which a variable assisting or opposing voltage is provided from some form of variable ratio transformer, or simply by a choking coil with movable core, but now usually limited to one with series and shunt windings, the relative position of which can be varied. Cf. MAGNETO VOLTAGE REGULATION.

Induction Relay. A relay in which the moving part is acted upon by forces due to currents induced therein.

Induction Roll Heater. An appliance to bring rolling mill rolls up to their working temperature before beginning work, in order to take up their final dimensions at once, by inserting them into alternating current carrying coils which induce eddy-currents in them, after the manner of an *Induction Furnace*.

Induction Type Synchronous Motor. A synchronous motor which is constructed so that it can be run up to speed without direct current excitation by allowing the field system to act as the rotor of an induction motor. After being run nearly up to speed in this way, a motor of this kind pulls itself into synchronism when the direct current excitation is switched on.

Induction Voltmeter and Wattmeter. See INDUCTION INSTRUMENTS.

Inductive Capacitance. See PERMITTIVITY.

Inductive Capacity, Specific. See PERMITTIVITY.

Inductive Circuit. A circuit possessing appreciable *Inductance*.

Inductive Compensation. *Compensation* of a single-phase motor, etc., by a coil which has a current induced in it, and is not conduc-

tively connected to the rest of the circuit.

Inductive Coupling. The connection of two circuits or parts of two circuits so that a change of current in one produces a change of magnetic flux linking the other, e.g. the primary and secondary of a transformer. (Also called *Electromagnetic Coupling*.) Cf. CONDUCTIVE and ELECTROSTATIC COUPLING.

Inductive Drop. See INDUCTANCE DROP.

Inductive Interference. Interference with telegraph or telephone circuits (either by affecting signals or by producing disturbing noise) caused by currents induced by neighbouring power circuits either in normal operation or owing to noises due to switching operations or short circuits. Such effects may be due to *Electromagnetic* or *Electrostatic Induction*.

Inductive Leak. A connection between some point in a telegraph circuit to earth having inductance as well as high resistance. Used to sharpen the signals in a similar way to a *Signalling Condenser* in Hughes duplex and repeating stations, etc., and proposed as a method to alleviate generally the effect of capacitance in long lines.

Inductive Load. A load on a generating station, etc., containing a large proportion of apparatus such as induction motors causing a low power-factor, i.e. in which the current lags behind the voltage producing it.

Inductive Loading. The provision of artificial or added inductance to a telephone line or cable to counteract the effect of capacitance, and to avoid distortion. See PUPIN COILS, CONTINUOUS LOADING, etc.

Inductive Reactance. See MAGNETIC REACTANCE.

Inductive Resistance or Resistor. A resistance coil, etc., possessed also of appreciable inductance.

Inductive Rise. See IMPEDANCE RISE.

Inductivity. See PERMITTIVITY.

Inductor. An apparatus of considerable inductance inserted in a circuit for that reason. For other

meanings see **INDUCTOR ALTERNATOR** and **MAGNETO INDUCTOR**.

Inductor : Current Limiting, Earth, Earthing, and Magneto. See **CURRENT LIMITING INDUCTOR**, **EARTH INDUCTOR**, etc.

Inductor Alternator. An alternator in which the rotating part is not provided with windings, but consists only of masses of iron or *Inductors* which by their movement vary the flux passing through the armature windings.

Inductor Loud Speaker. A type of *Loud Speaker* in which a pair of soft iron bars, on flexible parallel motion supports is directly connected to the cone or diaphragm and moves between laminated poles of magnets excited by the telephone current.

Inductorium. An old-fashioned name for an *Induction Coil*.

Indumor. An instrument consisting of a combination of adjustable pivoted scales which when set to the constants of an induction motor, will predict its performance without calculation.

Industrial Frequency. A term sometimes used for the range of frequencies used in ordinary electric supply and transmission, ranging from about 15 to 100 cycles per second.

Ineffective Call. A Telephone Call which has not resulted in the connection asked for.

Ineffective Call Meter or Register. An apparatus for registering the number of ineffective calls made by a subscriber.

Ineffective Call Meter Key. The key by which a telephone exchange operator actuates a particular ineffective call meter.

Inert Cell. A "*Dry*" Cell made up without moisture which can be kept unused for considerable periods without deterioration. A small quantity of water is introduced before the cell is taken into use.

Inertaire Transformer. An oil-immersed transformer with a space above the oil level filled with inert gas. There is provision for "breathing" but a device is provided to

eliminate the oxygen from the air drawn in.

Inerteen. A synthetic non-inflammable material of very high *Permittivity* used for impregnating the paper in condensers for power-factor improvement.

Inertia, Electromagnetic. See **ELECTROMAGNETIC INERTIA**.

Inferred Zero. The arrangement of a galvanometer or other instrument to obtain high sensitivity over a limited part of its possible range by applying an electrical or mechanical controlling force bringing the zero off the scale altogether, so that the full scale can be utilised for only a part of the full range.

Infinity Plug. A plug in a resistance box, the withdrawal of which breaks the circuit, i.e. introduces a practically infinite resistance.

Influence Machine. A machine for obtaining high electrostatic potentials from mechanical power by the relative movement of charged conductors having an inductive effect upon one another. See **WIMSHURST**, **HOLTZ**, **VOSS**, **BONETTI**, **TOEPLER**, **LEHMSTROM**, **WOMMELSDORF**, **PIDGERON**, and **TUDSBURY MACHINES**, and **CONTINUOUS ELECTROPHOROUS**.

Influence, Sphere of. See **SPHERE OF INFLUENCE**.

Infra-Acoustic Frequency. See **SUB-AUDIO FREQUENCY**.

Infradyne Reception. A system of wireless reception similar to the *Superheterodyne* system, except that the "intermediate" frequency is higher than that of the received wave instead of lower so that *Super-reaction* can be used.

Infra-Red Microscope. An apparatus similar to an *Electron Telescope* in which the optical image on the cathode of the *Image Tube* is produced by a projecting microscope employing infra-red rays.

Infra-Red Rays. Radiation of lower frequency than those of the red end of the visible spectrum, including "radiant heat." Their wave-lengths range from 0.00008 to 0.04 cm.

Infra-Red Therapy. Treatment of disease by infra-red radiation, of a wave-length over 7000 A.U.

Inherent Regulation. Voltage or speed regulation due to some feature of the apparatus itself such as the compounding of a generator or the differential winding of a motor, usually expressed as the percentage change between full and no-load under specified conditions. See REGULATION UP and REGULATION DOWN.

Ink Writer or Inker. A telegraph receiving instrument which marks the message in ink on a paper strip in the "longs" and "shorts" of the Morse Code.

Inner Conductor or Main. A term sometimes used for the neutral or middle conductor of a *Three-Wire System*, also sometimes used for the central conductor in a concentric cable. Cf. OUTER CONDUCTOR.

Inner-Pole Type Alternator and Generator. A generator in which the armature surrounds the field system such as the ordinary form of revolving field alternator or an obsolete type of direct current generator with a fixed pole system round which revolved an overhung armature with an external commutator.

Inphase Component (of Current or Voltage). See ACTIVE CURRENT and ACTIVE VOLTAGE.

Input. The power, measured mechanically in horse-power, etc., or electrically in kilowatts, etc., absorbed by a machine or apparatus and partly given out in a useful form and partly dissipated as *Losses*. See EFFICIENCY and OUTPUT.

Input Transformer. A transformer used between the final amplifier valve and a load speaker is spoken of as an "input" transformer when attached to the load speaker and as an "output" transformer when attached to the receiving set.

Inside Frosted Lamp. An incandescent lamp with the inside of the bulb frosted. Also called *Pearl Lamp*.

Inspection Fittings. Portions of an interior conduit system such as bends, etc., provided with remov-

able covers for access to the wiring.

Inspection Lamp. See HAND LAMP.

Inspection Plug. A plug in the cover of an accumulator cell, the removal of which enables tests of the specific gravity of the electrolyte to be made and its level to be observed.

Instability, Magnetic. (1) The conditions in a power system which cause some of the generators running in parallel to fall out of step when a certain load is reached, or when sudden voltage surges take place. (2) Conditions which give rise to unwanted oscillations in a thermionic valve or similar circuit. See also MAGNETIC INSTABILITY.

Installation. The complete arrangement of wiring and apparatus for the production or utilisation of electrical energy in a building, etc.

Instantaneous Action Circuit-Breaker, Relay, etc. A Circuit-Breaker, etc., arranged to come into action as soon as possible after the specified conditions of overload, etc., are attained. Cf. TIME LIMIT CIRCUIT-BREAKER, etc.

Instantaneous Power. In an alternating current circuit, the product of the e.m.f. and current at any instant which, in the case of currents out of phase with the voltage, may be negative for some parts of the cycle, meaning that power is being returned to the generating plant.

Instantaneous Values. The actual value at any instant of an alternating or otherwise varying current, e.m.f., etc., which may be anything from zero to its *Peak Value* according to the part of the phase. Cf. ROOT MEAN SQUARE VALUE, etc.

Instrument. In electrotechnics generally the term instrument is used to mean *Measuring Instrument*, or appliances of similar nature actuating control apparatus, but in telegraphy and telephony includes a considerable class of transmitting and receiving apparatus.

Instrument(s): Cathode-Ray, Change-Coil, Crossed Coil, Direct Reading,

Edgewise, Electrodynamic, Electrolytic, Electromagnetic, Electrostatic, Electron Jet, Electrothermal, Ferraris, Graphic, Gravity-Control, Hot-Wire, Illuminated Dial, Indicating, Induction, Integrating, Measuring, Moving Coil, Moving Conductor, Moving Iron, Moving Magnet, Permanent Magnet, Portable, Precision, Projected Scale, Recording, Rectifier, Registering, Sector Pattern, Shaded Pole, Shielded Pole, Single Pivot, Soft Iron, Split Electromagnet, Spring Control, Suppressed Zero, Switchboard, Telegraph, Thermal, Thermocouple, Thermo-Expansion, Unipivot, and Vibrating Reed. See CATHODE RAY INSTRUMENT, CHANGE COIL INSTRUMENT, etc. (See also references under *Meter*.)

Instrument Control. The arrangements made for the provision of the force in measuring instruments tending to keep the moving system in its zero position and opposing the deflecting force due to the quantity to be measured. See GRAVITY, SPRING, and MAGNETIC CONTROL.

Instrument Transformers. Small transformers used to couple ammeters, voltmeters, etc., to high voltage circuits so that only low voltages and low currents are brought to the instruments themselves. See CURRENT TRANSFORMERS and VOLTAGE TRANSFORMERS.

Insulance. A term proposed for *Insulation Resistance*, as preferable to *Insulation*.

Insulant. A term proposed for *Insulating Material* as preferable to *Insulator*, *Insulation*, or *Dielectric*.

Insulated Bolt. A bolt, the greater part of which is covered with insulating material.

Insulated Cable. Cable covered with a layer of insulating material with or without a further protective covering.

Insulated Circuit. A circuit which is insulated from the earth throughout. Cf. EARTHED CIRCUIT.

Insulated Clip. A clip carrying an insulated bush for the support of flexible cords, etc.

Insulated Hook. A hook carrying an insulated bush for the support of flexible cords, etc.

Insulated Middle Wire. The *Middle Wire* of a *Three-Wire* system which is not earthed at any point.

Insulated Neutral. The neutral point of a three-phase star connected system or apparatus when not connected to earth; also used to signify the insulated middle wire of a three-wire system. Cf. EARTHED NEUTRAL.

Insulated Pliers. Pliers used by wiremen with the handles covered with insulating material, to avoid possibility of shock when handling live wires.

Insulated Return System (in Electric Traction). Any system employing a separate insulated return conductor. Cf. TRACK RETURN.

Insulated Screw-Eye. A screw-eye carrying an insulating bush for supporting flexible cords, etc.

Insulated Supply System. A system of electricity supply in which no point in the circuit is purposely connected to earth.

Insulated Wire. Wire covered with insulating material throughout its length.

Insulated Wiring. Wiring in which no point of the circuit is earthed.

Insulating Beads. Beads of glass or other refractory insulating material strung over otherwise bare wire to form a flexible insulating protection; used for connections in arc lamps, heating apparatus, etc.

Insulating Boots. Boots made of insulating material to protect the wearer from shocks due to earth leakage, when liable to touch live conductors.

Insulating Bush. A bush of insulating material used to protect and to insulate conductors where they enter or leave structures of metal, etc.

Insulating Compound. Easily liquefiable mixtures of insulating materials used for such purposes as filling up joint boxes and impregnating fibrous materials to give them insulating and waterproof qualities.

Insulating Coupling. A shaft coupling which maintains insulation between two shafts such as that of a high tension generator and the turbine driving it. Used particularly in the *Thury System*.

Insulating Gloves. Gloves made of indiarubber or other insulating material to protect the wearer when handling live conductors.

Insulating Lacquer. A variety of spirit varnish sometimes used for metallic surfaces, e.g. insulating core plates from one another to prevent eddy currents.

Insulating Materials. The whole class of vitreous, resinous and other substances of sufficiently high dielectric or insulating property to be used for separating one conductor from another so that no appreciable current can pass between them.

Insulating Materials : Class A, Class B, Class C, Class O, and Impregnated. See CLASS A INSULATING MATERIALS, CLASS B INSULATING MATERIALS, etc.

Insulating Oil. Oil of special character rendering it suitable to be used for insulating purposes as in oil-immersed transformers, oil-break switches, etc., or for impregnating fibrous materials. See TRANSFORMER OIL, etc.

Insulating Screens, Stands, etc. Screens, stands, etc., of insulating material, arranged to protect persons working near high tension conductors from possibility of contact with live parts.

Insulating Tape. Tape impregnated with insulating materials, usually of an adhesive character, for covering joints, etc., in insulated cables and wires.

Insulating Tube. A tube of insulating material, for protecting electrical conductors where they pass through walls, partitions, etc.

Insulating Varnishes. Composition, containing dissolved gums and resins which, when applied to a surface in liquid form, will leave a protective and insulating film after drying at atmospheric temperature, or in an oven. They may be of the oil or spirit varnish class. The lighter qualities of the latter are

often called *Lacquers*. Varnishes are distinguished from paints by the absence of undissolved pigments. A mixture containing varnish and pigments is called an *Enamel* or *Enamel Paint*. See also IMPREGNATING MATERIAL.

Insulation. (1) The provision of layers, coverings, partitions or other separators of insulating material between conductors or between conductors and the earth, to prevent the flow of current where it is not desired. (2) The material employed for the purpose. See INSULANT. (3) The very high electrical resistance between the conductors thus insulated. See INSULATION RESISTANCE.

Insulation : Cambric, Double, Drying Out, Graded, Lamination, Lava, Liquid, Magnetic, and Oil. See CAMBRIC INSULATION, DOUBLE INSULATION, etc.

Insulation Resistance. The actual resistance in ohms, or more commonly in *Megohms* (millions of ohms), across the insulation of an installation, or piece of apparatus, allowing a leakage current to pass; measured either between two conductors, between one conductor and the frame of the machine, or between one conductor and earth. See INSULANCE.

Insulation Test and Testing. The measurement of the insulation resistance between the insulated and uninsulated portions of a machine, apparatus, or installation; or between the two poles of an installation with all the switches open, or with the switches closed and the lamps, etc., removed.

Insulation Tester. An instrument or set of instruments for measuring insulation resistance. See OHM-METER, MEGGER, etc.

Insulativity. Either the insulating property of a substance in general or the resistance of a centimetre cube of the substance between opposite faces; also called SPECIFIC RESISTANCE.

Insulator. (1) A substance having insulating property in a more or less perfect degree. See INSULANT. (2) A piece of insulating material made up into a suitable form for use

in insulating two conducting substances, such as the porcelain supports on which overhead lines are mounted.

Insulator : Accumulator, Aerial, Bushing, Cap and Pin Type, Ceramic, Chain, Floor, Globe Strain, Line, Link, Moulded, Oil, Petticoat, Pin Type, Porcelain, Puncture-proof, Section, Shackle, Strain, Suspension, Swan-necked, Tension, Terminal, Third Rail, Transposition, and Wall Entrance. See ACCUMULATOR INSULATOR, AERIAL INSULATOR, etc.

Insulator Arcing Horns. Curved metal horns attached to the ends of a string of suspension insulators to deflect the flash-over from the surface of the insulators.

Insulator Cap. A metal cap sometimes placed over the top of a porcelain insulator to equalise the mechanical stress due to the pull of the wire.

Insulator Pin. The central metal, or sometimes wooden, pin on which the ordinary upright or *Pin Type* line insulator is supported.

Intake Chamber. A chamber in which connections are made between supply or other cables entering a building and the installation within the building.

Integrating Frequency Meter. An instrument for integrating frequency with regard to time. Also called MASTER FREQUENCY METER.

Integrating Instruments. Meters which register the total quantity of electricity (*Ampere-Hours*), or of electrical energy (*Watt-Hours*), which has passed in a circuit during a given time. Cf. INDICATING and GRAPHIC INSTRUMENTS.

Integrating Meter and Wattmeter. See INTEGRATING INSTRUMENT.

Integrating Photometer. A photometer in which the average candle-power from a source in all directions or at all angles in one plane is determined by a single reading. See MESO-PHOTOMETER and ULBRICHT GLOBE.

Integration : Continuous, Discontinuous, and Intermittent. See CON-

TINUOUS INTEGRATION, DISCONTINUOUS INTEGRATION, etc.

Integrator, Photometric. See PHOTOMETRIC INTEGRATOR.

Intensifier Circuit. See INTERMEDIATE CIRCUIT.

Intensifying Screen. A fluorescent screen mounted in close contact with a photographic plate to reinforce the effect in taking an "X" Ray photograph.

Intensity. This term has been used at different times with different meanings. The older writers when speaking of the "intensity" of a current simply meant its voltage, as opposed to its "quantity" by which they signified the strength of the current (amperes). This use survives in *Intensity Coil* and "*Q and I*" Detector. Some modern writers have appropriated the term to mean strength of current. Hence the symbol *I* for current which has superseded the letter *C*. The term "Electric Intensity" has also been used for *Potential Gradient*. When applied to "X" Rays "intensity" signifies the energy received per unit area of a surface at right angles to the rays. See also INTENSITY OF MAGNETISATION.

Intensity : Coercive, Luminous, Mean Horizontal, Mean Lower Hemispherical, Mean Spherical, and Mean Upper Hemispherical. See COERCIVE INTENSITY, MEAN HORIZONTAL INTENSITY, etc.

Intensity Coil. An old-fashioned name for an *Induction Coil*.

Intensity Fading. *Fading* due to causes other than *Phase Fading*.

Intensity of Electric Field. See FORCE.

Intensity of Magnetisation. The density of the magnetic lines of force due to the magnetisation of the material in a magnetic circuit, i.e. lines per unit cross-section, apart from the lines due to any field due to neighbouring currents or magnets which is also present. (Also definable as the magnetic moment per cu. cm.). (Cf. MAGNETIC INDUCTION. Symbol: *J*).

Intensive Arc Lamp. An *Enclosed Arc Lamp* working at a high current density.

Intensive Reflectors. Reflectors designed to concentrate the light where it is required. Cf. **EXTENSIVE REFLECTOR**.

Interceptive Collective Automatic Lift-Control. A system of *Automatic Lift Control* in which all calls made from landings or cars are ultimately answered. Cf. **SELECTIVE** and **DIRECT COLLECTIVE AUTOMATIC LIFT CONTROL**.

Interchange Current. See **CIRCULATING CURRENT**.

Intercommunication Switch. A switching device whereby any one of a group of telephones can be connected.

Intercommunication Telephones. A telephone installation in a large office, etc., in which any station can call up and speak to any other without the medium of an exchange operator.

Interconnected Star Connection. See **ZIG-ZAG CONNECTION**.

Interconnector, Interconnecting Feeder, or Interconnecting Main. A main connecting two distributing centres for load equalisation or provision of an alternative route in case of breakdown, or connecting two generating stations for mutual assistance.

Interconnecting (in Automatic Telephony). The connecting together of *Level Multiples* so that the links are available from different sections in a different order.

Interelectrode Capacitance (of a Thermionic Valve). The capacitance between any two electrodes, e.g. the grid and the plate; of greater importance the higher the frequency in avoiding self-oscillation. By suitable arrangements, its effect can be balanced out. See **NEUTRODYNE RECEPTION**.

Interference. (1) The spoiling of received wireless messages by the effect of extraneous waves including the effects of neighbouring electrical apparatus. See **INTERFERENCE PREVENTER** and **JAMMING**. (2) In general, the harmful reaction of power, traction, and other heavy current circuits on telegraph or telephone circuits. The expression is also used in a

still more general sense to include effects of neighbouring and associated telephone circuits.

Interference, Harmonic and Inductive. See **HARMONIC INTERFERENCE** and **INDUCTIVE INTERFERENCE**.

Interference Preventer. Additional wireless telegraph receiving circuits, slightly out of tune with the main receiving circuit, arranged to have opposing actions upon the main receiver, when practically equal forced oscillations are produced in both main and auxiliary circuits, so that the effects of all waves not producing a markedly preponderating resonance in the main circuit cancel out.

Interference Suppressor. A system of capacitance and inductance applied to plant to prevent interference with neighbouring wireless receiving apparatus.

Interferic Space. See **AIR GAP**.

Interior Conduit. Steel or other tubes for containing wiring in the interior of buildings. See **CONDUIT**.

Interior, Porcelain. See **PORCELAIN INTERIOR**.

Interior Wiring. A system of conductors throughout a building for electric light, heating, or power purposes. See references under **WIRING**.

Interlaced Scanning. A system of *Scanning* in television in which the whole field is covered in several stages known as frames, each consisting of lines not included in the previous frame. The spaces left out being covered in subsequent frames.

Interlock. Any mechanical or electrical device for ensuring interdependence of the action of different portions of switchgear or other apparatus.

Interlock, Gate. See **GATE INTERLOCK**.

Interlock Protective System. A system of feeder protection not entailing the continuous employment of special pilot wires but provided with relays, which on fault conditions occurring switch over momentarily to existing communication circuits and cause them to fulfil the functions of pilot wires.

Interlocking (Electrical). Contactors relays, etc., are said to be "electrically interlocked" when their windings are connected to circuits so interconnected that they can only come into action in a predetermined sequence or when predetermined conditions have been reached as in the case of a contactor, starter, or controller giving *Automatic Acceleration*.

Interlocking Switch. A switch interlocked electrically or mechanically with others, so that they can only be opened or closed in a certain sequence.

Intermediate Cable. A lightly armoured type of submarine telegraph cable, intermediate between *Shore End* and *Deep Sea* types.

Intermediate Circuit. An additional tuned oscillating circuit, used in some forms of wireless receiving apparatus, inductively coupled between the aerial circuit and the detector circuit in order to obtain greater selectivity.

Intermediate Distribution Frame. The frame in a telephone exchange, where connections are made between the wires coming from the *Main Distribution Frame*, i.e. from the external circuits and the various internal circuits of the exchange.

Intermediate Frequency Amplifier. An *Amplifier* in a *Supersonic Heterodyne* receiver working at the Beat frequency.

Intermediate Relay. See *REPEATER*.

Intermediate (Telegraph) Station. One of a number of telegraph stations in series on a main telegraph line where no connection is made to earth and messages can be sent or received in either direction.

Intermediate Switch. A *Branch Switch* constructed as a reversing switch without an off position, for use in conjunction with a pair of *Landing Switches* (two-way switches) where control of a light or group of lights is required from more than two points. Its action is to reverse the connection between the landing switches so that the "off" position becomes the "on" position, and *vice versa*.

Intermediate Waves. An expression

defined by the International Radio-Technical Committee to mean waves between 50 and 200 metres (6,000–1,500 kc.). Cf. *LONG, MEDIUM, SHORT, and VERY SHORT WAVES*.

Intermittent Contact Recorder. A *Graphic Instrument*, or Recorder, in which the marking device is only brought into contact with the chart at intervals. Cf. *THREAD RECORDER*.

Intermittent Current. A unidirectional current continually interrupted at regular or irregular intervals.

Intermittent Earth or Fault. An *Earth* or other *Fault* in a circuit depending on varying conditions and not continuously present.

Intermittent Integration. The action of an integrating motor which does not make a true continuous integration of the current, etc., but only sums up values taken at regular intervals. Cf. *CONTINUOUS INTEGRATION*.

Intermittent Rating. The rating of a motor or other piece of apparatus according to the output it can give when working for alternate periods of load and rest having a definite ratio to one another, or when running for a stated period only, insufficient to cause it to reach its final temperature, followed by an indefinite period of cooling. See *LOAD-FACTOR RATING, ONE HOUR RATING*, etc.

Intermittent Running. Conditions of running of a motor, etc., where the cycle of operations involves alternate regular or irregular periods of load or rest.

Internal Capacitance. See *SELF-CAPACITANCE*.

Internal Characteristic. A curve connecting the internal e.m.f. in a dynamo-electric machine (not the terminal voltage after the drop has been subtracted) with the current. Cf. *EXTERNAL CHARACTERISTIC*.

Internal Circuit. The path of a current within a piece of apparatus such as a battery, generator, etc., or the circuits forming part of the installation within a building. Cf. *EXTERNAL CIRCUIT*.

Internal Conductor. The central conductor in a concentric cable.

Internal Field Alternator. An alternator in which the armature surrounds the field, e.g. the usual form of revolving field alternator.

Internal Impedance. The impedance of a thermionic valve between the filament and the plate, as defined by the ratio of change of anode voltage to change of anode current on the straight part of the characteristic with constant grid potential. The internal impedance is approximate constant over a large range of frequency.

Internal Isolation Switchgear. A form of ironclad switchgear in which the circuit-breakers can be withdrawn for inspection after disconnecting from the rest of the circuit by withdrawal of internal plug connections actuated from outside.

Internal Resistance. The *Resistance* of the internal circuit between the terminals of a piece of apparatus such as a cell or battery, or the armature of a generator.

Internal Self-Inductance. An expression used in connection with cables and other conductors for the inductance due to the field within the conductor. Considerably greater in iron or steel than in copper conductors. Cf. EXTERNAL SELF-INDUCTANCE.

Internal Voltage. The actual e.m.f. generated in the armature of a machine without deduction of the potential drop when a current is flowing through it.

International Ampere. The value of an unvarying current which, when passed through a silver voltameter of specified form, deposits 0.00111800 grammes of silver per second. Equal to 0.99991 true ampere. See INTERNATIONAL UNITS.

International Candle. The recognised unit of *Luminous Intensity*, adopted by agreement between the Standardising Laboratories of Great Britain, France, and the U.S.A. Equal to the value of the French *Bougie Decimale*, 0.104 of the *Carcel Lamp*, 1.11 of the *Hefner Lamp* and 0.98 of the old English

Standard Candle. See CANDLE POWER.

International Coulomb, Farad, Gilbert, Henry, Joule, and Maxwell. Units based on the *International Ampere* and *International Ohm*, and having values respectively of 0.99991, 0.99943, 0.99991, 1.00052, 1.00034, and 1.00043 of the true values of the coulomb, farad, etc.

International Ohm. The resistance offered to an unvarying current by a column of mercury at the temperature of melting ice, 14.4521 grammes in mass, of constant cross section, and of a length of 106.300 centimetres. Equal to 1.00052 true *Ohm*.

International Units. The system of units of electrical measurement recognised by law in most countries, based upon the values of the standards representing the *International Ampere* and *International Ohm* agreed upon at the International Conference in London in 1908.

International Volt. The e.m.f. or electrical pressure which when applied to a conductor, the resistance of which is one *International Ohm*, will produce a current of one *International Ampere*. Equal to 1.00043 true *Volt*.

International Watt. The energy expended in one second by an unvarying current of one *International Ampere* under an electrical pressure of one *International Volt*. Equal to 1.00043 true *Watt*.

Internode. See ANTINODE.

Interphone. Contraction for *Intercommunication Telephone*.

Interpolator. A form of *Regenerative Repeater* for retransmitting signals over a long cable received through a relay in a clearer form.

Interpole. See COMMUTATING POLE.

Interpole Motor. A motor fitted with *Commutating Poles*.

Interrupted Continuous Waves. *Modulated Key-Controlled Continuous Waves* in which the audio-frequency modulation consists of periodic interruption.

Interrupted Current. A current which is periodically interrupted, but does not change its direction and is in that sense a "direct current."

Interrupted Ringing. *Power Ringing*

broken up into alternate periods of ringing and silence by a power-driven commutator.

Interrupter. An apparatus for producing a regular periodic interruption of a current; e.g. as required for the primary circuit of an *Induction Coil*.

Interrupter: Atonic, Automatic, Caldwell, Electrolytic, Hammer, Mercury, Motor-driven, Ringing, Simon, Wehnelt. See ATONIC INTERRUPTER, AUTOMATIC INTERRUPTER, etc.

Interruption Cable. A short length of cable used in repairing overhead lines, etc., which is connected across the span to be worked on before the lines in question are cut.

Intersheath. A metallic layer such as a lead tube at an intermediate point in the insulation of a cable to control the voltage gradient in the dielectric by being maintained at a definite intermediate pressure by connection to transformer tapplings or otherwise.

Intertrack Bond. A conducting connection between rails of separate tracks on electric railways and tramways.

Intervalve Coupling. Any method of coupling thermionic valves in cascade so that the current variations in the plate circuit of one valve reappear as voltage variations on the grid of the next. See INTERVALVE TRANSFORMER, RESISTANCE-CAPACITANCE COUPLING, and TUNED ANODE COUPLING.

Intervalve Transformer. A transformer for coupling *Thermionic Amplifiers in Cascade*.

Intrinsic Brightness. See INTRINSIC BRILLIANCY.

Intrinsic Brilliancy. The *Brightness* (candle power emitted per unit projected area in a particular direction), of a source itself emitting light.

Inverse Current. A current induced by the cessation or diminution of a neighbouring current or field; i.e. in a contrary direction from that induced by the establishment or increase of such a current or field.

Inverse Power Factor. The reciprocal of power factor (i.e. $\sec \phi$) forming a convenient multiplier for con-

verting kilowatts into kilovolt-amperes, and giving the proportion of wattless current.

Inverse Speed Motor. A motor which, if no adjustment of the circuit is made, decreases in speed as the load increases, and vice versa.

Inverse Time Element, Time Lag, or Time Limit. A time-lag arrangement in a circuit-breaker, etc., whereby the time elapsing between the attainment of the specified conditions of overload, etc., and the operation of the breaker is roughly inversely proportional to the magnitude of the overload, etc. Cf. DEFINITE TIME LAG.

Inversion, Thermo-Electric. See THERMO-ELECTRIC INVERSION.

Inverted Arc Lamp. A direct current *Arc Lamp*, arranged with the positive carbon above the negative carbon in order that the greater part of the light, coming from the crater, shall be directed upwards as required for indirect lighting.

Inverted Brush Contacts. A form of laminated switch contact in which the laminations are carried on the fixed, instead of the moving, element. Usually so arranged that the forces due to the current tend to increase the contact pressure.

Inverted Dynamo. See UNDERTYPE DYNAMO.

Inverted "L" Aerial. An aerial consisting of one or more horizontal wires, to which connection is made by a vertical wire at one end, having a certain amount of directive effect, the signals being strongest in the direction of the horizontal wires. Cf. "T" TYPE AERIAL.

Inverted Line Circuit. A compensating circuit containing a suitable combination of inductances, capacitances, and resistances used in wireless transmitting stations to minimise distortion produced by telephone lines over which relayed transmissions are received.

Inverted Machines. Machines such as induction motors, synchronous motors, etc., in which the supply current is taken to the rotor instead of to the stator. A construction sometimes used in *Synchronous Induction Motors*.

Inverted Rectifier. An apparatus supplied with direct current and delivering alternating current.

Inverted Repulsion Motor. A form of repulsion motor in which the single phase supply is taken to the armature through the brushes, and the field windings are short circuited.

Inverted Rotary Converter. A *Rotary Converter* used to convert from alternating to direct current.

Inverted Vacuum Tube. A thermionic valve used for voltage reduction power amplification by using the plate circuit as a high voltage input circuit, and the grid circuit as the output circuit.

Inverter. A term sometimes used for an *Inverted Rectifier*, particularly of the thermionic type.

Inverter, Speech. See *SPEECH INVERTER*.

Involute Connections. *Butterfly* and other armature *End Connections* of a curved form.

Iodide Accumulator. See *HALOGEN ACCUMULATOR*.

Ion. A minute dissociated portion of a substance carrying a positive or a negative charge. Used (1) of the dissociated portions into which molecules split up during electrolysis. See *ANIONS* and *CATIONS*; and (2) of constituent dissociated corpuscles into which gases split up when ionised; the positive and negative ions having respectively a deficiency or an excess of *Electrons*. A current through an ionised gas consists of processions or streams of electrons detached in this way. See *POSITIVE* and *NEGATIVE IONS*, *MIGRATION OF IONS*, *IONISATION*, etc.

Ionic Beam. See *IONIC JET*.

Ionic Current. A current through a gas carried by ions or electrons.

Ionic Focusing (in a Cathode Ray Tube). Control of the concentration of the electron jet by alterations of the p.d. and filament temperature, which affect the radial electrostatic focusing field, automatically produced by the accumulation of positive ions, due to their superior mobility; also called *Gas Focusing*.

Ionic Jet. An expression preferable

to electron jet where it contains heavy ions and is not composed purely of electrons.

Ionic Medication. See *MEDICAL IONISATION*.

Ionic Mobility. See *MOBILITY*.

Ionic Mobility, Specific. See *SPECIFIC IONIC MOBILITY*.

Ionic Transmitter. See *CATHODOPHONE*.

Ionic Speed or Velocity. The velocity of *Migration of the Ions* in an electrolyte, different for anions and cations and for different substances. See *MOBILITY*.

Ionic Valve. Any apparatus using the properties of ionised gases or liquids for the conversion of the nature of a current, e.g. as a *Rectifier* or *Inverter*.

Ionic Wind. A stream of air produced at a sharply pointed portion of a charged conductor where the density of the charge is high, due to repulsion of ions which collide with uncharged molecules, sweeping the whole away together. Also known as *Electric Wind*.

Ionic Wind Voltmeter. An instrument for measuring high voltage by observing the change in resistance of a filament heating a point terminal caused by the cooling effect of the *Ionic Wind* produced. See also *Thermo-Electrostatic Relay*.

Ionics. The science of the properties and movement of ions.

Ionisation. Dissociation of molecules of a gas on an electrolyte into ions, causing it to become more conducting. In the case of a gas, this can be done by the action of ultra-violet light and certain rays from radioactive materials, by dielectric stress and some forms of electric discharges, and by flames and incandescence. See also *MEDICAL IONISATION*.

Ionisation Chamber. An instrument for gauging the intensity of "X" Rays by measuring the degree of ionisation of a gas.

Ionisation Current. A current through an ionised gas due to ionic streams. See *ION*.

Ionised Gas Detector. Detectors of electric waves of the vacuum tube oscillation valve or thermionic tube type.

Ionosphere. The whole ionised zone of the upper atmosphere including the *Kennelly-Heaviside* (E_1 and E_2) and the *Appleton* (F_1 and F_2) *Layers*. This ionization is probably due to ultra-violet radiation from the sun. It is reflection from the ionosphere which renders reception by long and medium waves over much longer distances possible by night than by day. The structure of the ionosphere is considerably affected by magnetic storm conditions. See also **FADING** and **SKIP DISTANCE**.

IR Drop. The voltage drop due to resistance in a current-carrying conductor; proportional to the current (I) multiplied by the resistance (R).

I^2R Loss. The power loss in a current-carrying conductor due to its resistance, proportional to the square of the current (I^2) multiplied by the resistance (R). See **COPPER LOSS**.

Iridium Lamp. An early form of incandescent lamp with a "filament" of iridium wire.

Iron (Electric). A flat iron for domestic laundry and other uses heated by passing a current through resistances in the body of the iron, by a flexible cable.

Iron Losses. The portion of the energy losses in electrical machines, apparatus, etc., due to *Eddy Currents* and *Hysteresis* in the iron cores forming the magnetic circuit. Cf. **COPPER LOSSES**.

Iron Tester, Differential. See **DIFFERENTIAL IRON TESTER**.

Ironclad Dynamo or Motor. An early name for a dynamo or motor with inwardly projecting poles so that the yoke forms a case surrounding the whole machine.

Ironclad Electromagnet. An electromagnet in which the return magnetic circuit is formed by a tube of iron covering the winding.

Ironclad Switchgear, etc. Switchgear, etc., in which the live parts are entirely covered in by iron casings.

Ironless Armature. A machine such as some of the earlier alternators in which the armature was entirely without an iron core.

Ironless Circuit. A magnetic circuit entirely without iron.

Irradiation. Exposure of a body to "X" rays or other radiation.

Irregularity. This term is sometimes used in connection with rectified or other pulsating current for the ratio of the alternating to the mean direct component.

Irregularity, Cyclic. See **CYCLIC IRREGULARITY**.

Irregularity Factor. The ratio of the speed variation to the mean speed, during one revolution, of a generator driven by an engine of unequal crank effort.

Irwin Hot-Wire Oscillograph. See **HOT-WIRE OSCILLOGRAPH**.

Island Furnace. A form of arc furnace for the *Fixation of Nitrogen* with a fixed electrode surrounding a rotating electrode.

Isle-of-Man Connection. See **ZIG-ZAG CONNECTION**.

Isochronism. The running, exactly in step at equal speed, of two shafts, etc., such as those of the selecting devices in some forms of printing telegraph systems, where the sending and receiving apparatus is kept in step by periodical correcting current impulses, or in general the performance of related functions at the same speed.

Isynchronous Circuits. Circuits having the same natural period of oscillation.

Isoclinals or Isoclinic Lines. Lines on a magnetic map passing through points of equal *Dip* or *Inclination*. Cf. **AGONIC LINES**.

Isodynamic Lines. Lines on a magnetic map, passing through points of equal horizontal component of the earth's magnetic field.

Isodyne Reception. A system of wireless reception employing bigrid h.f. amplifying valves in such a way that the currents in the two grid circuits compensate any tendency to self-oscillation.

Isogonals or Isogonal Lines. Lines on a magnetic map passing through points of equal *Declination*. Cf. **AGONIC LINES**.

Isolated Generating Plant. Generating plant for giving a supply for electric light or power to a house

or establishment independently of any public supply system.

Isolated Phase Switchgear. High tension switchgear in which the apparatus in each phase is in a separate cell or cubicle.

Isolating Links or Isolating Switches. See ISOLATORS.

Isolating Transformer. A transformer used between the output terminals of the loud speaker or receiving telephone to avoid direct connection with the high tension circuit.

Isolation. In English, the term "Isolation" is not used (as it is in some languages) for *Insulation*, but means disconnection from the rest of the circuit, usually at a time when no current is passing.

Isolators. Links for simple switches for disconnecting parts of a circuit from the live conductors adapted for use only when no current is passing.

Isoperm. One of a group of special alloys of nickel, iron and copper or aluminium used for cores of

inductance coils on account of the small variation of permeability and good magnetic stability.

Isotopes. Varieties of an element of the same chemical properties and atomic number, but with a nucleus containing a different number of mass units but the same atomic charge. Many elements, as usually occurring, have been found to consist of a mixture of isotopes with different integral mass numbers.

Isotropic Conductivity. Conductivity of a body which is the same in every direction therein. Cf. ANISOTROPIC CONDUCTIVITY and UNILATERAL CONDUCTIVITY.

Isthmus Method. A method of subjecting samples of material to very high magnetic inductions for testing purposes by causing them to form a narrow neck in the magnetic circuit of an electromagnetic of large dimensions.

I.T.E. Circuit-Breaker. See INVERSE TIME LIMIT.

J]

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J. Abbreviation for *Joule*: symbol for *Intensity of Magnetisation*.

Jablochkoff Candle. A primitive form of arc lamp without mechanism, consisting of two carbon rods, side by side, separated by plaster of Paris, so that the arc played across their tips. To avoid unequal carbon consumption, alternating currents only were employed and the arc once extinguished by a temporary interruption of current could not be restarted.

Jack. The receptacle on a telephone or telegraph switchboard, etc., provided with a metallic bush and several contact springs behind the board for making contact with a plug attached to a flexible cord, the various parts of the plug making contact with the different springs and also separating contacts normally existing between the springs or closing contacts normally open. (Formerly sometimes called *Switch-Springs*.)

Jack: Ancillary, Branching, Break, Five Point, Multiple, and Test. See ANCILLARY JACK, BRANCHING JACK, etc.

Jack Shaft. An intermediate shaft in electric locomotives of the side rod type, carrying the cranks from which the wheels are driven through connecting rods and coupling rods.

Jack Strip. A number of jacks made up side by side into a strip for mounting in compact rows on a telephone switchboard.

Jackson Tube. An early form of "X" Ray Tube with inclined anticathode in which a concave cathode was introduced to focus the cathode rays, but an auxiliary anode was not employed. Cf. GUNDELACH TUBE.

Jacobi's Unit of Resistance (Jacobi Etalon). A resistance unit proposed in 1848, being that of a copper wire weighing 22.4932 grammes,

761.975 mm. long and 0.667 mm. in diameter.

Jamming (1) The sending of disturbing wireless messages or waves to interfere with the reception of another message, as in the operations of fleets in war time. (2) Interference due to any signals other than those it is desired to receive.

Jandus Arc Lamp. A form of vertical carbon *Enclosed Flame Arc Lamp*, with special arrangements for giving a circulating movement to the enclosed gases to avoid deposit from the funes on the globe.

Jar. A practical unit of electrostatic capacity used in the British Navy, equal to 1/900 microfarad.

Jar, Electric or Leyden. See LEYDEN JAR.

Jars, Syntonic. See SYNTONIC JARS.

Jet Wave Rectifier. The equivalent of a commutator rectifier formed by pairs of stationary commutator segments upon which a jet of mercury impinges. Part of the jet carries an alternating current of the same frequency of the supply, and is in a strong d.c. field so that it is deflected from side to side and thus makes contact alternately with the two segments.

Jig. A term used by some writers on wireless telegraphy to signify a single train of damped oscillations.

Jigger. A high frequency transformer as used in the aerial circuit of a wireless transmitting equipment.

Jockey Relay. A delicate relay of the moving coil type, used in cable telegraphy, automatically corrected for stray earth currents by an arrangement analogous to a shifting zero in which the "fixed" contacts are caused to drift or change their position according to the earth currents.

Johnsen-Rahbek Effect. See ELECTROSTATIC ADHESION.

Johnson Noise (in Wireless Receivers).

A background noise due to thermal electron agitation in grid circuits.
Cf. **SHOT EFFECT**.

Joint: Butt-Welded, Cable, Lead Sleeve, Magnetic, Mechanical, Non-tension, Scarf, Sealing In, Sleeve, Soldered, Spliced, Straight Through, Tee, Tension, Twisted Sleeve, and Welded. See **BUTT-WELDED JOINT, CABLE JOINT, etc.**

Joint Box. A box, usually of cast iron (but sometimes, as in the case of single core a.c. cables, of non-magnetic material), into and out of which cables are led, containing a cable joint or joints; sometimes filled up with compound.

Joint Testing. Tests of joints in conductors, cables, etc., required to be made to ensure that the joint is not inferior to the rest of the cable in (1) mechanical strength, (2) electrical conductivity, and (3) insulation.

Joining Chamber. An underground chamber into which cables are led through ducts, and where joints can be made.

Jona's Method. See **GRADED CABLE** (1).

Joule (J.). A "practical" unit of energy usually applied to the measurement of heat developed by a current; being the quantity of energy developed from the expenditure of one watt for one second, i.e. 10^7 C.G.S. electromagnetic units. Equivalent to 10^7 ergs, 0.239 Calories, 0.00094 B.Th.U., 0.73756 ft.-lbs., or 0.277778 kWh, (named after J. P. Joule, 1818-1889).

Joule Effect. The heating effect of a current passing through a resistance.

Joule's Law. The heat developed by a current in a circuit is proportional to the square of the current multiplied by the resistance and the time. ($I^2 R t$ Joules.)

Jump Spark. A spark discharge between two conductors, at a constant distance apart, at a voltage sufficient to allow the spark to "jump" across. Cf. **WIPE SPARK**.

Jumper. Any cable or wire, usually flexible, used to make a temporary or permanent connection between two conductors, but not taking mechanical tension.

Jumper Cable. A flexible cable connecting two *Coupler Plugs*.

Jumper Head. See **COUPLER PLUG**.

Jumper Receptacle. See **COUPLER SOCKET**.

Jumper Wire (in Automatic Telephony). A temporary connecting wire in a *Cross-connection Field* during repair or rearrangement of permanent connections.

Jump-Over Distance. See **SKIP DISTANCE**.

Junction: Thermo-Electric. See **THERMO-ELECTRIC JUNCTION**.

Junction Box. See **JOINT BOX**.

Junction Calls. Calls made or received at a telephone exchange over a *Junction Line*.

Junction Circuit. (1) A circuit at a telephone exchange connected to a *Junction Line*. (2) Such a circuit together with a *Junction Line*.

Junction Key. A key on a telephone switchboard for signalling through a *Junction Line*.

Junction Line. A telephone line from one exchange to another, in the same district. Cf. **TOLL LINE** and **TRUNK LINE**.

Junction Line: Incoming and Outgoing. See **INCOMING JUNCTION LINE** and **OUTGOING JUNCTION LINE**.

Junction Selector (in Automatic Telephony). A *Selector* responding to the current impulses of the *Exchange Code* in a call dialled, the function of which is to make connection through a vacant junction line between a *First Selector* and an appropriate *Thousands Selector* in the wanted exchange.

Jungner Accumulator. A variety of nickel-cadmium *Accumulator* with alkaline electrolyte.

Jute Insulated Cable. Cables insulated with impregnated jute, with or without lead covering and armouring: used for pressures up to about 2,000 volts.

K]

K. Symbol for *Luminosity Factor*; and for *Modulation Percentage*.

K_f. Symbol for *Form Factor*.

k. Symbol for *Coupling Coefficient*.

Kapp Coefficient. A coefficient depending upon the wave form, pitch factor and spreading factor of an alternator by which the number of turns in series multiplied by the flux and divided by 10^8 has to be multiplied to obtain the virtual voltage (named after Gisbert Kapp).

Kapp Line. A unit of magnetic flux, formerly employed in dynamo design, equivalent to 6,000 C.G.S. units, in order to avoid dividing by 60 to reduce the speed to revs. per sec. instead of revs. per min.

Kapp Vibrator. A *Phase Advancer* for connection to the slip ring circuit of an induction motor on the principle that a leading c.m.f. is generated in a conductor allowed to swing freely in an alternating field, consisting of a small diameter armature with commutator, for each phase, allowed to reciprocate freely in a continuous current field. Cf. *RECUOPERATOR*.

Kappa (K) symbol for *Permittivity* (dielectric constant).

Karolus Cell. An apparatus capable of being used as a light relay depending upon the variation of the polarising power of certain liquids in a magnetic field.

Karolus System of Phototelegraphy. A system of phototelegraphy in use on the Continent in which a photoelectric cell is used in the transmitter and a *Kerr Cell* in the receiver, considerable use being made of thermionic amplification.

Kathions, Kations, Kathode, etc. See CATHIONS, CATIONS, CATHODE, etc.

Kc. Abbreviation for *kilocycles per second*.

Keeper A piece of iron, commonly

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used across the poles of a permanent horseshoe magnet, to complete the circuit when the magnet is not in use, so as to avoid the self-demagnetising effect of leakage lines.

Keller Furnace. An electric furnace for iron smelting, etc., in which the heating effect is produced partly by the passage of the current through the charge itself from carbon electrodes and partly by arcs between the electrodes and the charge. Cf. *ARC* and *INDUCTION FURNACES*.

Kelvin. A name proposed by the Board of Trade (in 1892), for the commercial unit of energy, one *Kilowatt-Hour* or one *Board of Trade Unit*. (Named after William Thomson, Lord Kelvin, 1824-1907.)

Kelvin Absolute Electrometer. See *ABSOLUTE ELECTROMETER*.

Kelvin Arrival Curve. See *ARRIVAL CURVE*.

Kelvin Balance. See *AMPERE BALANCE*, *COMPOSITE BALANCE*, etc.

Kelvin Bridge. A method of measuring low resistances in which the potential drops produced by the same current in the resistance under test and in a standard low resistance slide wire are balanced against each other, also called *Double Bridge*.

Kelvin Compass. A form of ship's compass introduced by Lord Kelvin with a particularly light card, a number of short parallel needles held by silk cords and other special features.

Kelvin Effect. See *THOMSON EFFECT*.

Kelvin Marine Galvanometer. A compact form or sensitive moving magnet reflecting galvanometer for submarine cable work.

Kelvin Quadrant Electrometer. See *QUADRANT ELECTROMETER*.

Kelvin's Law. The statement that the most economical size of conductor to employ for a transmission

line, etc., is that which makes the annual cost of the energy lost in the conductor equal to the interest and depreciation on its initial cost.

Kennelly-Heaviside Layer. The lower section of the *Ionosphere* or ionised layer in the upper atmosphere, between which and the earth's surface the waves used in wireless communication follow the curvature of the earth, owing to being reflected or refracted thereby. Now regarded as being divided into the M_1 layer about 100 km. up and the M_2 layer existing during daytime about 130 km. up. There is, however, some variation in the heights. See also *Ionosphere* and *APPLETON LAYER*.

Kenotron. The name given to an early form of two-electrode thermionic valve tube for use as a rectifier, having a high enough vacuum to depend on a full electron discharge.

Kerr Cell. A light relay used in phototelegraphy, etc., depending for its action on the *Electrostatic Kerr Effect*.

Kerr Effect. The rotation of the plane of polarisation of plane polarised light when reflected from the pole of a magnet. The angle of rotation is proportional to the intensity of magnetisation.

Kerr Effect, Electrostatic. See *ELECTROSTATIC KERR EFFECT*.

Kerr's Constant. The number, varying for different wavelengths and for different materials, by which the intensity of magnetisation has to be multiplied to give the angle of rotation forming the *Kerr Effect*.

Kettle (Electric). A kettle for electrical heating of water usually with a heating unit in its base and sometimes provided with an automatic arrangement for cutting off the current when the kettle becomes empty to prevent damage by overheating.

Kew Pattern Magnetometer. A delicate form of reflecting magnetometer with photographic self-recording arrangements to keep a continuous record of the changes in the earth's magnetic field.

Key. (1) An apparatus for opening

or closing a circuit by hand or otherwise at will, as for signalling purposes, usually of the class in which the contact member is flexed and not pivoted. (2) A piece of metal fitting in a groove for locking two bodies, such as an armature and a shaft, together to prevent relative movement between them. (3) A *Slot Wedge*.

Key: Armature, Back Contact, Charge and Discharge, Circumferential, Clearing, Double Current, Firing, Increment, Junction, Listening, Meter, Mixing, Morse, Party-Line Ringing, Register, Reversing, Ringing, Short-circuit, Signalling, Single Current, and Speaking. See *ARMATURE KEY, BACK CONTACT KEY, etc.*

Key-Holder. A lamp holder containing a switch.

Keying. Arrangements in wireless telegraphy for breaking up trains of waves into morse signals either by interrupting them altogether when the signalling key is released or making an alteration in frequency.

Keyless Ringing. Ringing of the telephone bell at a distant station by making connection to the line without the use of a separate key.

Key-Sender. An appliance for the control of automatic telephone apparatus by depressing keys.

Key-Set Call Sender. A *Calling Device* actuated by keys.

Key-Switch. A switch actuated by turning a small flat handle resembling that of a key, as often fitted to lampholders.

Kicking Coil. See *CHOKING COIL*.

Kilburn Scott Furnace. A three-phase arc furnace for the *Fixation of Nitrogen*.

Kilo- Prefix meaning a thousand times, e.g. kilovolt, a thousand volts. Abbreviation: *k*.

Kilo-Ampere Balance. A Kelvin current balance having a range of from 25 to 2,500 amperes.

Kilo-Calorie. See *CALORIE*.

Kilocycle. One thousand cycles. In wireless telegraphy, etc., it is often more convenient to specify frequency in kilocycles per second instead of wave-length in metres,

especially when considering questions of interference of stations of only slightly different wave-length. Their frequencies should differ by at least 10 to 15 kilocycles per second. The frequency in kilocycles per second equals 300,000 divided by the wave-length in metres.

Kilohertz. A proposed unit of frequency equal to one kilocycle per second.

Kilohm. Abbreviation of Kilo-ohm, 1000 ohms.

Kilo-Line. A unit of magnetic flux sometimes used in dynamo design, etc., equal to one thousand C.G.S. lines or *Maxwells*.

Kilovar. Practical Unit of *Reactive Power* equal to 1000 reactive volt-amperes.

Kilovarhour. 1000 reactive volt-amperes-hours.

Kilovolt. (kV.) One thousand volts. A unit often used for expressing voltages of h.t. transmission lines, test pressures for insulators, etc.

Kilovolt-Ampere. (kVA.) A unit of *Apparent Power* used in rating alternators, etc., being 1,000 *Volt Amperes*.

Kilovolt-Ampere-Hour Meter. A meter integrating the kilovolt ampere-hours supplied to a circuit.

Kilowatt. (kW.) The unit of electric power generally used for rating electrical machinery and for other practical purposes; equal to 1,000 watts. Equivalent to 1.34 h.p.

Kilowatt-Hour. (kWh.) The unit of electrical energy usually employed for commercial purposes, being that which has passed in a circuit when an average of one kilowatt has been passing for one hour or its equivalent. (Also called the *Board of Trade Unit* and the *Kelvin*.)

Kilowatt-Hour Meter. A meter integrating the power supplied to a circuit, i.e. measuring the energy supplied in a given time in kilowatt hours.

Kinescope. The reproducing apparatus in the form of cathode ray television in which the amplified received signal impulses vary the strength of an electrostatically

focused electron beam which is caused by suitable deflecting coils to scan a fluorescent screen in synchronism with the scanning beam in the transmitter (see *Iconoscope*), rendering it luminous in proportion to the light falling on to the transmitting screen.

Kipp Oscillations. High-frequency oscillation with a large percentage of harmonics and an almost triangular wave form.

Kirchhoff's Laws. (1) At any point where circuits branch from one another the algebraic sum of the currents meeting at that point is zero. (2) The total e.m.f. in a circuit is equal to the sum of the resistances of its various parts multiplied by the current in the circuit.

Kirkifier. Popular name for a thermionic valve detector system, using the valve as an anode rectifier with the space charge neutralised by a positive *Grid Bias*.

Kjellin Furnace. An electric *Induction Furnace* without terminals in contact with the charge, in which the charge forms the secondary of a transformer and the heating effect is due to the powerful currents induced in it.

Klaxon Horn. See *HORN* (Electric).

Klirr Factor. The ratio between the r.m.s. values of the fundamental wave in an oscillation to that of the harmonics present. See *Coefficient of Non-linear Distortion*.

Klydonograph. An instrument for the recording of surges in transmission systems, etc., depending on the photographic reproduction of Lichtenberg figures on a moving film.

Knee (of Magnetisation Curve). See *Magnetisation Curve*.

Knife Switch. A switch in which the moving part is a blade, like that of a knife, pivoted at one end and with an insulating handle at the other. This completes the circuit by being inserted between a pair of spring contacts close together, one terminal being connected to the pivot. An alternative set of spring contacts converts

it into a *Double Throw Switch* and several blades can be coupled to one handle to make *Double* and *Triple Pole Switches*.

nowles Cell. A cell for the production of hydrogen (and oxygen) by the electrolysis of an alkaline solution.

Koepsal Permeameter. An instrument for measuring the permeability of an iron or steel bar, in the form of a moving coil instrument, in which the sample in an exciting coil forms part of the magnetic circuit. The deflection of the moving coil by a known current is the measure of the *Induction*.

Kohlrausch Bridge. A *Wheatstone's Bridge* with alternating current supply and a telephone receiver instead of a galvanometer. Suitable for measuring resistance in which a back e.m.f. is present, etc.

Kolster Direction Finder. See *WIRELESS DIRECTION FINDER*.

Korn System (of Phototelegraphy). A system of *Phototelegraphy*, employing, in its original form, a transparent original, every part of which is traversed by a beam of light modifying the resistance of a selenium or other light sensitive cell and thus causing modulation of the line current according to the density of the portion of the original passing. These modulations control a shutter by an arrangement similar to an *Eindhoven String Galvanometer* which causes corresponding variations in a beam falling upon the synchronously moving film in the receiving apparatus. In another form of the system a metallic original in relief is employed with which a metal stylus makes contact when it passes over a raised portion.

KR A symbol formerly frequently employed in telegraphy for the product of the capacitance and resistance

of a cable or line, upon the reciprocal of which the working speed (words per minute) depends. The expression *OR* is now more commonly used.

KR Law. See *OR Law*.

Krämer (Motor) Control. An economical method of obtaining speed variation in an induction motor for rolling mill drive, etc., by connecting to the slip rings an auxiliary three-phase commutator motor, coupled to the same shaft, which utilises the energy that would otherwise be wasted in resistances in the rotor circuit. In some cases a direct current motor driven through a rotary converter takes the place of the three-phase commutator motor. Cf. *SCHERBRUS SYSTEM*.

Krarup Cable. A particular form of continuously loaded telephone cable, in which a ribbon of high permeability material is wound around the core.

Kundt's Effect. The rotation of the plane of polarisation of plane polarised light when passed through a film of iron, sufficiently thin to be transparent, placed transversely in a magnetic field. Cf. *KERR EFFECT*.

kVA. Abbreviation for *Kilovolt-Ampere*.

K_{var} Abbreviation for *Kilovar*.

K_{varh} Abbreviation for *Kilovar-hour*.

kW. Abbreviation for *Kilowatt*.

kWh. Abbreviation for *Kilowatt-Hour*.

Kymograph. An apparatus for recording by "X" rays the movement of internal organs in which the film is exposed through a series of slits and moved periodically by a distance equal to that between them. By this means the equivalent of a direct record of the movement is automatically made.

[L]

L. Symbol for *Self-inductance*: also *Quantity of Light*.

Labyrinth Protection. The rendering of any apparatus for collieries flame tight by providing a long and tortuous path for the passage of the flame of an internal explosion whereof it is cooled and extinguished before it can reach the exterior.

La Cour Converter. See MOTOR CONVERTER.

Lack of Symmetry Error (in a Wireless Direction Finder). Inaccuracy of reading due to unequal distribution of current in the two halves of a loop due to geometric or inductive asymmetry.

Lacquer, Insulating. See INSULATING LACQUER.

Lag: Angle of, Magnetic, and Time. See ANGLE OF LAG, MAGNETIC LAG, etc.

Lagging Current. An alternating current is said to "lag" behind the voltage which produces it when its wave is out of phase with that of the voltage in a direction such that it reaches its maximum after that of the voltage wave. Cf. LEADING CURRENT.

Lagging Load. A load in which the current lags behind the voltage. (Also called *Inductive Load*.) Cf. LEADING LOAD.

Lalande Cell. A zinc-iron primary cell with caustic soda electrolyte and copper oxide depolariser.

Lambda (λ). Symbol for *Wavelength*.

Lambert. A unit of *Brightness* being that of an ideal white surface receiving one lumen per square centimetre equal to 0.718 candles per sq. cm. For practical purposes the *Milli-Lambert* is more convenient. See also FOOT LAMBERT.

Lambert's Law. See COSINE LAW.

Lamellar Magnetisation or Magnetism. Magnetisation so distributed in a sheet or plate that the whole of the front forms one pole and the

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whole of the back forms the other. A "Lamellar Magnet" thus formed is sometimes called a *Magnetic Shell*. Cf. SOLENOIDAL MAGNETISATION.

Laminated Brush. (1) A dynamo brush made up of a number of layers, insulated from one another to make the resistance greater in the transverse direction than along the length of the brush. (2) A laminated contact for a switch.

Laminated Brush Switch. A switch with *Laminated Contact*.

Laminated Conductors. Armature and other conductors, built up of strips, wholly or partially insulated from one another, to diminish eddy currents within the conductor, or to make them more flexible.

Laminated Contacts. Switch contacts made up of a number of laminations each more or less free to be pressed into contact with the opposite conducting surface.

Laminated Core. The *Core* of a transformer, armature, etc., built up of stampings of sheet iron or steel, more or less perfectly insulated from one another by paper, varnish, or otherwise to diminish eddy currents.

Laminated Magnet. (1) A permanent magnet built up of independently magnetised strips of steel with the object of attaining a high intensity of magnetisation. (Also called a *Compound Magnet* and *Magnetic Battery*.) (2) An electromagnet for alternating current with a laminated core.

Laminated Pole. A field magnet pole piece built up of laminations to diminish eddy currents within the pole and incidentally to enable material of higher permeability to be used. Such laminated poles are sometimes cast into the yoke.

Laminated Pole-Shoe. The actual

face of a field magnet pole built up of laminations and secured to the solid pole by screws, etc.

Laminated Yoke. A field magnet Yoke built up of laminations used in some types of alternating current motors, etc., to diminish eddy currents.

Lamination Insulation. Paper, varnish, etc., used between laminations to insulate them one from another to diminish eddy currents.

Laminations. Sheet iron stampings for being built up to form a transformer, armature, or other *Laminated Core*.

Lamont's Law. The statement that the permeability of steel at any flux density is proportional to the difference between the saturation value of the flux density and its value at the point in question. This is only approximately accurate and does not hold on the initial part of the magnetisation curve.

Lamp (Electric). An appliance for producing light by electrical means; used sometimes to signify the removable portion containing the actual light giver, as an incandescent lamp with its bulb and terminals, or to include the complete apparatus with current supply, e.g. miner's lamp, pocket lamp, etc., or a fitting complete with lamp, e.g. table lamp, hand lamp, etc.

Lamp: Ancillary, Arc, Automatic Arc, Bastian, Battery, Beck Arc, Blackening of Incandescent, Blondel Arc, Brake-Wheel Arc, Cadmium Vapour, Calling, Candle, Capillary, Carbon, Carbon Arc, Carbon Filament, Carcel, Cathode Ray, Cell Inspection, Clearing, Clutch Arc, Comparison, Compressed Air, Cooper-Hewitt, Daylight, Decorative, Differential Arc, Discharge, Disconnecting, Double, Carbon Arc, Electron Discharge, Enclosed Arc, Enclosed Flame Arc, Filament, Finsen, Flame, Flame Arc, Flaming Arc, Flash, Flood, Focus, Focusing Arc, Frosted, Gas-Discharge, Gas-Filled, Glim, Glow, Glow-Discharge, Graphitised Filament, Half-Watt, Hand, Hand Regulated Arc, Head, Hefner, Helium, Heraeus, Hot Cathode Discharge, Hot Wire Arc,

Incandescent, Inclined Carbon Arc, Induction, Inspection, Intensive Arc, Inverted Arc, Iridium, Jandus Arc, Line, Luminescence, Luminous Arc, Luminous Gas, Magazine Arc, Magnetite Arc, Mercury Arc, Mercury Discharge, Mercury Vapour, Metal, Metal Filament, Metallic Filament, Metallised Filament, Meter, Miner's, Moore Tube, Multifilament, Neon, Neon Induction, Nernst, Opal, Open Arc, Osglim, Osmium, Osram, Overshooting of, Pearl, Pentane, Pilot, Pocket, Pointolite, Portable, Projector, Projector Type Filament, Quartz, Regenerative Arc, Semi-Arc, Semi-Incandescent, Series, Series Arc, Sheringham Daylight, Shunt Arc, Signal, Silica, Smashing point of, Sodium Discharge, Sodium Vapour, Spot, Sprayed, Standard, Sunlight, Supervisory, Surgical, Synchronising, Table, Tantalum, Titanium Carbide, Traction, Tubular, Tungsten, Tungsten Arc, Twin Carbon Arc, Ultra-Incandescent, Ultra-Violet, Uviol, Vacuum, Vacuum-Tube, Wire, Zinc Vapour, and Zirconium. See ANCILLARY LAMP, ARC LAMP, etc.

Lamp Cap. The brass or other cap at the base of an incandescent lamp complete with the terminals attached thereto. See BAYONET CAP, EDISON SCREW CAP.

Lamp-Holder. The appliance mounted on an electric light fitting, etc., which holds the lamp in place and makes contact with its terminals. (Sometimes called *Lamp Socket*.)

Lamp-Holder: Bayonet, Central Contact, Edison Screw, Goliath, Locking. See BAYONET LAMP-HOLDER, etc.

Lamp-holder Plug. An appliance for connecting a flexible cord to an ordinary lamp-holder.

Lamp Resistance. A resistance composed of one or more incandescent lamps.

Lamp Socket. See LAMP-HOLDER.

Lamp Synchroscope. A *Synchroscope* in which the moment when synchronism is reached is indicated by the cessation of flicker of incandescent lamps.

Lancashire Booster. An *Automatic Reversible Battery Booster*, in which

no exciter is employed, but the booster machine is provided with four field windings connected respectively across its own armature, across the bus-bars, in series with the main current and in series with the booster armature. Various adjusting rheostats are provided. Also called *Turnbull-McLeod Booster*. Cf. *HIGHFIELD* and *ENTZ BOOSTERS*.

Land Line. A telegraph line across the land as opposed to a submarine cable circuit.

Landing Call Push. A push button on a landing for calling the car of an automatic electric lift or one calling for the attendant in a non-automatic lift.

Landing Switch. (1) A branch switch constructed as a two-way switch to form one of a pair of switches to control a light, or group of lights, from two points or in conjunction with *Intermediate Switches* from more than two points. (2) In lift control: A switch stopping the car at a landing, actuated by a ramp on the car.

Lap Coil. An armature coil with each turn of the same size so that they overlap each other instead of the inner turns lying entirely within the outer as in a *Spiral Coil*.

Lap Winding. An armature winding in which the opposite ends of each coil are connected to adjoining commutator segments, the winding thus turning backwards upon itself to form each loop; in the case of a multipolar machine sometimes called a *Multicircuit Winding* and requiring as many sets of brushes as there are poles. Cf. *WAVE WINDING*.

Large Calorie. See *CALORIE*.

Laryngaphone. A telephone transmitter in which the voice vibrations are taken up by a pad pressed on to the exterior of the throat instead of from the sounds issuing from the mouth; of value in noisy situations in that it does not pick up extraneous sounds.

Last Party Release. A system whereby a telephone circuit is cleared when both parties have hung up their receivers.

Latent Magnetisation. The property

of metals, themselves feebly paramagnetic, of forming more or less strongly magnetic alloys or compounds, e.g. manganese, chromium, and vanadium.

Latitude, Magnetic. See *MAGNETIC LATITUDE*.

Lattice Coil. (1) A form of inductance coil for wireless receiving sets with low distributed capacitance with an arrangement of spaced-out coils crossing one another, those of each layer lying over those of the next but one, so as to form intersecting walls. (2) Armature coil with *Lattice Connections*.

Lattice Network. See *RECURRENT CIRCUIT*.

Lattice Connections. Armature *End Connections* which cross over one another in a regular pattern. Cf. *CONCENTRIC CONNECTIONS*.

Lattice Winding. A winding with *Lattice End Connections*.

Latour Alternator. See *BETHENOD-LATOURE ALTERNATOR*.

Latour-Winter-Eichberg Motor. A single-phase commutator motor for traction work of the compensated repulsion type.

Launch (Electric). A boat propelled by electric motors, supplied with current from accumulators on board, charged at intervals from fixed charging stations ashore.

Lava Insulation. A natural insulating mineral ($Mg_3H_2Si_4O_{12}$) easily turned, threaded, etc., and suitable for such purposes as are lamp and rheostat bushes, etc.

Lay (of a strand in a Cable). The axial pitch of one complete turn of the strand.

Lay Ratio (of a strand in a Cable). The ratio of the lay to the mean diameter of the helix formed by the strand.

Layer: Appleton, "D," "E," "F," Heaviside and Kennelly. See *APPLETON LAYER* "D" LAYER, etc.

Lead. (1) See *ANGLE OF LEAD*. (2) A flexible or other wire or cable conveying current to a piece of apparatus.

Lead: Angle of, Backward, Brush-, and Forward. See *ANGLE OF LEAD*, *BACKWARD LEAD*, etc.

Lead or Lead-Acid Accumulator. An

- accumulator in which the electrodes of the cells are of lead containing an active material of certain lead oxides which alter their composition during charging and discharging, in an electrolyte of dilute sulphuric acid. See POSITIVE and NEGATIVE PLATES.
- Lead Cell.** See LEAD ACCUMULATOR.
- Lead Covered Cable.** See LEAD COVERING.
- Lead Covered Cable, Plain and Served.** See PLAIN LEAD COVERED CABLE and SERVED LEAD COVERED CABLE.
- Lead Covering.** A protective covering of lead over cables to prevent the entry of moisture, especially with paper and other hygroscopic insulation.
- Lead Grip.** A device for making contact with the lead sheathing of a cable at a junction box to ensure conductive continuity of the sheathing.
- Lead In.** See LEADING-IN WIRE (2).
- Lead Press.** A machine by which cables are lead covered by an extrusion process.
- Lead-Rubber.** Rubber into which is incorporated a large percentage of lead; used for gloves, aprons, etc., for protection of "X" ray operators.
- Lead Sheathing.** See LEAD COVERING.
- Lead Sleeve Joint.** A joint in a lead covered cable in which, after the conductor is jointed, a lead sleeve is drawn over the joint, secured to the lead covering by plumber's wiped joints and, in some cases, filled up with insulating compound through a hole afterwards closed by a screw cap.
- Lead Tree.** If a solution of a lead salt be electrolysed, the deposit of lead at the cathode takes the form of a tree with slender branches that can be seen to grow in the electrolyte.
- Leader Cable (or Pilot Cable).** A cable laid at the bottom of a navigable channel or along a route, carrying an alternating current for the guidance of ships, aeroplanes, etc., in fog, etc., which pick up signals from this cable by suitable receiving apparatus.
- Lead-in Insulator.** See BUSHING INSULATOR.
- Leading Current.** An alternating current is said to "lead," when owing to the effect of capacitance, etc., it reaches the maximum of its wave sooner than the voltage which produces it.
- Leading Edge (of a Brush).** The *Entering Edge*.
- Leading-In Tube.** See BUSHING INSULATOR.
- Leading-In Wire.** (1) A wire passing through, and sealed air-tight into, the glass of an incandescent lamp or vacuum tube to convey current to the filament or an electrode. Usually of platinum or a metal with approximately equal coefficient of expansion to that of glass. (2) A wire passing into a building through a suitable insulator to make connection from an outside conductor such as a wireless aerial.
- Leading Load.** Load in which the current leads in front of the voltage, due to the presence of capacitance or the effect of synchronous motors, etc. (Also called *Capacitance Load*.) Cf. LAGGING LOAD.
- Leading Phase** (in the two wattmeter method of power measurement). The circuit in which the current is in advance in phase of the voltage taken to the wattmeter connected herewith.
- Leading Pole Horn or Tip.** The tip or horn of a field pole which is reached first by an armature conductor in a machine of constant direction of rotation. Cf. TRAILING POLE HORN, etc.
- Leads, Preventive.** See PREVENTIVE LEADS.
- Leak.** An intentionally or accidentally provided path, through which part of the current can return through the earth or to the opposite conductor. See also LEAK COIL and LEAK CIRCUIT.
- Leak: Grid, Inductive, and Static.** See GRID LEAK, INDUCTIVE LEAK, etc.
- Leak Circuit.** A very high resistance shunt circuit such as that used in *Repeater Stations* with a galvanometer or receiver to observe the character of the transmitted signals

without diverting enough current to affect them.

Leak Coil. A high resistance coil used in telegraphy for shunting a condenser.

Leakage. See LEAKAGE CURRENT and MAGNETIC LEAKAGE.

Leakage: Belt, Brow, Coefficient of, Differential, Double Linkage, End, Higher Harmonic, Magnetic, Main, Peripheral, Secondary, Slot, Surface, Tooth Top, Unequal Linkage, and Zig-Zag. See BELT LEAKAGE, BROW LEAKAGE, etc.

Leakage Coefficient. See LEAKAGE FACTOR.

Leakage Conductance. The reciprocal of *Leakage Resistance* or *Insulation Resistance*.

Leakage Current. A current through a fault or through imperfect insulation, generally to earth, or between two mains. Usually confined to currents of small value. Cf. FAULT CURRENT and STRAY CURRENT.

Leakage Detector. See LEAKAGE INDICATOR.

Leakage Factor (or *Leakage Coefficient*). The ratio of the total flux in the magnetic circuit of a machine, transformer, etc., to the useful flux linking the armature or secondary winding, etc.

Leakage Field or Flux. That part of the total magnetic flux in a machine, transformer, etc., which does not link the armature or secondary winding, etc.

Leakage Indicator. An instrument for indicating or measuring the presence of a leakage current to earth on a system; usually by indications of the potential difference between the respective poles of the system (if normally insulated) and earth, or in systems earthed at one point, consisting of an ammeter in the earth wire.

Leakage Protective System. A *Protective System* coming into action only upon the occurrence of leakage currents to earth.

Leakage Resistance. See INSULATION RESISTANCE.

Leakage Winding. See PARSONS and LAW'S LEAKAGE METHOD of Compounding Alternators.

Leakance. The reciprocal of insulation resistance, i.e. conductance

between one pole of a circuit and the other, or in such cases as a telegraph cable between cable and core and earth.

Leaving Edge (of a Brush). The edge which is the last part of the brush to make contact with any point in the commutator.

Leblanc Recuperator. See RECUPERATOR.

Lecher Circuit or Lecher Wires. An arrangement of two parallel wires coupled electrostatically to an oscillator for revealing by the aid of a neon tube, or otherwise, the presence of stationary electric waves in the wires, the position of the nodes and loops of which can be determined.

Leclanché Cell. A primary cell much used for bell and other circuits with zinc and carbon electrodes, an electrolyte of sal ammoniac, and a depolariser of manganese dioxide packed with powdered coke in a porous pot round the carbon pole. See also AGGLOMERATE LECLANCHÉ CELL.

Left-Hand Machine. A direct current machine in which the direction of rotation of the armature is counter-clockwise when viewed from the commutator end.

Left-Hand Rule. See FLEMING'S RULE.

Left-Handed Winding. See HAND.

Leg. The term leg is preferred by some to *Branch* or *Phase* for one of the single-phase circuits which make up a three-phase system.

Legal Ohm. A unit of resistance agreed upon in 1884 by an international congress at Paris, but not actually recognised by law; defined as the resistance of a column of mercury 1 sq. mm. cross section and 106 cm. long at 0°C; equal to 0.99718 *International Ohm*.

Legal Standard Wire Gauge. See BRITISH STANDARD WIRE GAUGE.

Lemstrom Machine. A form of electrostatic *Influence Machine* in which the tinfoil carriers are mounted upon concentric cylinders revolving in opposite directions.

Lenard Rays. The name given to cathode rays which have bombarded and succeeded in passing through an aluminium "window" out of

the tube in which they were produced.

Lenard Tube. A discharge tube arranged for the production of *Lenard Rays*.

Lenard Window. See **LENARD RAYS**.

Lengthening Coil or Lengthening Inductance. Additional inductance in an aerial circuit to make it respond to a longer wave length. (Sometimes called *Loading Coil*.)

Lengths, Hanging. See **HANGING LENGTHS**.

Lenoir Coil System (of Ignition). The original system of electric ignition for internal combustion engines, introduced by Lenoir in 1860, employing a battery, induction coil, and high tension distributor.

Lens: Electron, Electrostatic, Magnetic, and Wave. See **ELECTRON LENS, ELECTROSTATIC LENS**, etc.

Lenz's Law. The direction of induced currents is such that the forces produced by their reaction tends to oppose the motion producing them.

L.F. Abbreviation for *Low Frequency*.

Lepel Discharger. A *Quenched Spark* discharger for wireless systems, employing shock excitation; used in conjunction with an audio-frequency oscillating circuit to obtain a musical spark.

Lepel System of Wireless Telegraphy. See **LEPEL DISCHARGER**.

Level (in Automatic Telephony). One row in a *Bank of fixed Contacts* in a *Selector*.

Level Compounding. See **FLAT COMPOUNDING**.

Level Multiple. A term used for the whole group of multiples in one level of a section.

Level Raiser. A term sometimes used for *Repeater*.

Lever-Type Brush-Holder. A brush holder in which the carbon block forming the brush is held in rigidly in jaws at the end of an arm pivoted about the brush spindle and held up by a spring. Cf. **BOX-TYPE BRUSH-HOLDER**.

Lever-Type Starter. A motor starter, in which a single arm carries contacts moving over a series of fixed contacts in the same plane. Cf. **DRUM and MULTIPLE SWITCH STARTERS**.

Leyden Jar. A condenser in the form of a glass jar with inner and outer coatings of tinfoil, the former of which is connected to an external knob. So named because it originated at the University of Leyden (Holland).

Lichtenberg's Figures. Patterns formed by dusting an *Electroscopic Powder* on to an insulating plate which has been locally electrified (e.g. by touching one point with the knob of a charged Leyden Jar) or appearing on the development of a photographic plate which has been subjected to a high potential at one point. The patterns produced differ in character in positive and negative charges.

Lieben-Reiss Relay. An early form of three-electrode thermionic valve with oxide-coated filament practically contemporary with the *de Forest Audion*.

Life Tests (of Incandescent Lamps). Tests of sample incandescent lamps by running for a long period to ascertain how their candle-power diminishes with use, and the average period of use before the filament breaks. See **USEFUL LIFE**.

Lift (Electric). A passenger or goods lift worked electrically; usually by a winding drum driven by an electromotor started and stopped when required through the medium of a controller actuated externally or from the interior of the car.

Lift, Automatic. See **PUSH BURTON LIFT CONTROL**.

Lift Control: Automatic, Car-Switch, Dual, Push Button, Semi-automatic, Signal, and Rope. See **AUTOMATIC LIFT CONTROL, CAR-SWITCH LIFT CONTROL**, etc.

Lift Controller. An apparatus containing switch-gear, resistances, etc., for starting, stopping, and applying a brake to a lift motor; usually of the contactor or other automatic type, which cuts out the starting resistance gradually once the circuit has been made; actuated either mechanically by a rope or bar or, through relays, by switches or push buttons. See references under **LIFT CONTROL**.

Lift Motor. A motor coupled or

- geared to a winding drum to operate a lift.
- Lift Motor, Auxiliary.** See **AUXILIARY LIFT MOTOR.**
- Lifter, Brush.** See **BRUSH-LIFTER.**
- Lifting Magnet.** A powerful electromagnet, fed with current through flexible leads, used instead of a crane hook for lifting iron and steel objects by its attraction and releasing them when the current is cut off.
- Light.** See **VISIBLE RADIATION** and **RADIATION.**
- Light (Electric).** Light produced when and where required by the passage of a current through an electric lamp, by the production of an arc, the heating of a filament to incandescence, the glowing of a rarefied gas or otherwise. See **LAMPS, LIGHTING, etc.**
- Light(s) : Bunch, Electromagnetic Theory of, Flood, Proscenium, and Spot.** See **BUNCH LIGHT, ELECTROMAGNETIC THEORY OF LIGHT, etc.**
- Light Centre Length.** The distance from the geometric centre of the filament to the back of the cap in an incandescent lamp; of importance in relation to the correct position of a lamp in a reflector.
- Light Current Engineering.** See **ELECTRICAL ENGINEERING.**
- Light Load.** A machine is said to be on "light load" when it is only giving a small proportion of the full load that it is designed for.
- Light Relay.** An apparatus used in *Phototelegraphy*, etc., in which current variations are converted into variations in the intensity of a beam of light, e.g. by the displacement of a beam falling upon a special shaped aperture. See also **KAROLUS CELL.**
- Light Sensitive Cell.** Any form of "cell" in which the current transmitted varies with the amount of light falling upon it, whether of the *Photo-Emissive*, *Photo-Conductive*, *Photo-Voltaic* or other type. See **PHOTO-ELECTRIC CELL.**
- Light-Voltaic Cell.** See **PHOTO-VOLTAIC CELL.**
- Lighting (Electric).** The provision of illumination from electric lamps

- of suitable sizes and in suitable positions, with or without shades, reflectors, or globes to distribute the illumination in accordance with requirements.
- Lighting : Arc, Automobile, Decorative, Diffused, Direct, Festoon, Flood, Incandescent, Indirect, Semi-Indirect, Spot, Stage, Street, Strip, and Train.** See **ARC LIGHTING, AUTOMOBILE LIGHTING, etc.**
- Lighting Load.** A load on a generating plant or station consisting entirely of lighting and not of electric motors, or that part of the load due to lighting.
- Lighting Peak.** The *peak* in the lighting load curve, not usually occurring at the same time as the *Power Peak*.
- Lightmeter.** A form of portable *Illumination Photometer*.
- Lightning.** The visible flashes produced by electrostatic spark discharges from one part of a cloud to another, or in either direction between cloud and earth, through the atmosphere; several somewhat conflicting theories have been advanced to account for the way in which the very high potentials between different parts of a cloud are produced due to the formation of drops or ice crystals under the influence of upward currents of air.
- Lightning : Ball, Bead, Forked, Globular, and Sheet.** See **BALL LIGHTNING, BEAD LIGHTNING, etc.**
- Lightning Arrester.** An apparatus for preventing harmful effects of high voltage surges due to lightning, in installations involving overhead lines, by providing a spark gap, across which the discharge can pass to earth, with suitable means to prevent the arc thus established being maintained by the working voltage. For the different kinds of lightning arrester see under **ARRESTER.**
- Lightning Conductor.** A metal conductor or system of interlinked conductors, terminating in an elevated point higher than the highest point of a building, efficiently connected to earth and designed to present as little opposition as possible to the flow of highly

oscillatory currents, with the object of preventing the building in question being struck by lightning by affording an easy passage for discharge to earth.

Lightning Generator. See SURGE GENERATOR.

Lightning Guard. An apparatus used at junctions between a submarine cable and a land telegraph line to disconnect the cable from the land line and put it to earth automatically, by the melting of a fuse or otherwise, on the land line being affected by lightning.

Lightning Protection. The protection of buildings from the effects of lightning by the provision of efficient lightning conductors.

Lightning Protector. See LIGHTNING ARRESTER and LIGHTNING CONDUCTOR.

Lightning Rod. See LIGHTNING CONDUCTOR.

Lightning Severity Indicator. An instrument for recording lightning discharges by the effect on a moving film of a glow discharge lamp illuminated by the surge produced by the lightning.

Lightning Stroke Recorder. An instrument of the Klydonograph type arranged to record surges due to lightning discharges.

Lightning Switch. A throw-over switch used to connect a wireless aerial to earth instead of to the transmitting or receiving apparatus.

Light-Voltaic Cell. A light-sensitive cell of the photo-emissive type.

Lillienfeld Tube. A form of "X" Ray Tube with a heated filament forming the cathode of an auxiliary circuit and projecting electrons through a hollow working cathode connected to the main high voltage circuit.

Lime Spot Cathode. A *Hot Cathode* in an "X" Ray or other Cathode-Ray Tube in which the action is augmented by the provision of a small quantity of lime which emits electrons freely when incandescent.

Limit: Heating, Sparking, and Thermal. See HEATING LIMIT, SPARKING LIMIT, etc.

Limit Bridge. A form of *Wheatstone bridge* for rapidly making routine

tests of resistances of manufactured products in which instead of bringing the galvanometer deflection to zero for every test, observation is simply made that the deflection is within certain limits, indicating that the resistance of the article tested lies within the specified tolerance.

Limit Device (in Wireless Telegraphy, etc.). An arrangement for limiting the response of a receiver however great the strength of the incoming signals.

Limit Indicator. See CURRENT LIMITER.

Limit Switch. (1) A switch for automatically breaking a circuit when a lift or the moving part of some mechanism, etc., has reached the utmost allowable limit of its travel. (2) A relay in some forms of traction controller for automatic acceleration which is actuated by the drop of the main motor current below a certain value. (Also called THROTTLE SWITCH.)

Limit Switch, Control, Final, Main, and Terminal. See CONTROL LIMIT SWITCH, FINAL LIMIT SWITCH, etc.

Limiter, Current. See CURRENT LIMITER.

Limits of Induction. The maximum values attained in both directions by the induction during a cycle of magnetisation.

Line. (1) Any electric circuit for telegraph, telephone, power or lighting purposes, etc., not buried underground or under water, or a collection of such circuits carried on a single series of poles. (2) An unofficial name formerly used indiscriminately for the C.G.S. electromagnetic units of magnetic force, field, or flux.

Line: Acclinic, Agonic, Air, Artificial, Bus, Contact, Control, Direct, Duplex, Equipotential, Extension, Individual, Isoclinic, Isogonal, Junction, Kapp, Land, Loaded, Neutral, Overhead, Party, Pole, Scanning, Short Haul, Subscriber's, Telegraph, Telephone, Tie, Toll, Tower, Train, Transmission, Trolley, Trunk, and Volt. See ACCLINIC LINE, AGONIC LINE, etc.

Line Balance. An artificially made-up impedance applied at the end of a telephone line used for transmitting music, etc., to balance out the distorting effects of the line.

Line-Breaker (in Electric Traction). A contactor in the main circuit which cuts the current off when the master controller is in the off position and is also fitted with an over-load release.

Line Characteristic. The constant of a telephone cable, etc., sometimes called *Line Impedance*, upon which depends the current propagated in it by a periodic c.m.f. represented by the vector quantity, $\sqrt{R+j\omega L}/\sqrt{S+j\omega C}$, where R = resistance in ohms per mile, L = inductance in henries per mile, S = dielectric conductance in mhos per mile, C = capacitance in farads per mile, $\omega = 2\pi \times$ frequency, and $j = \sqrt{-1}$.

Line Choking Coil. An inductor used in the leads to any apparatus or machine to protect it from surges from the line.

Line Drop. The difference between the voltage at two different points in a line, due to the effects of resistance, inductance, capacitance, and leakage.

Line Finder. See PRE-SELECTOR.

Line Frequency (in Television). The number of scanning lines traversed per second.

Line Impedance. See LINE CHARACTERISTIC.

Line Insulator. A porcelain or other insulator used to support and to insulate a line wire from the pole or other structure upon which it is mounted.

Line Lamp. A lamp on a telephone switchboard which glows when a call is being made through the particular subscriber's or junction line to which it belongs.

Line Loss. The sum of the various energy losses in a transmission line due to effects of resistance, leakage, and corona discharge.

Line Noise. Disturbing noise in a telephone due to causes inherent in the line and to variations in resistance due to bad contacts, or induct-

tive interference of power lines, etc. Cf. TERMINAL NOISE.

Line Relay. A relay which controls a *Line Lamp* on a telephone exchange switchboard.

Line Selector. See PRE-SELECTOR.

Line Switch (in Automatic Telephony). See PRE-SELECTOR.

Line Telephony, Telegraphy, Telegraphy and Television. Telephony, telephony and television over metallic circuits as distinguished from wireless telegraphy, etc.

Line Voltage. See VOLTAGE BETWEEN LINES.

Lineal Decrement. The difference between successive amplitudes of a periodic function diminishing according to a law where this difference is constant. (Cf. LOG-ARITHMIC DECREMENT.)

Linear Amplification. Amplification by a *Thermionic* valve in which the change in the anode current is directly proportional to the change in the applied potential; i.e. when the valve is being worked on the straight line portion of its characteristic.

Linear Distortion. *Amplitude, Distortion or Phase Distortion* where the alteration of the quantities in question is not dependent upon the voltage or current amplitudes.

Linear Hysteresis. Magnetic *Hysteresis* under alternating flux as opposed to that in a rotating field.

Linear Modulation. *Modulation* in which the amplitude is strictly proportional to that of the impressed sound wave at all audio frequencies.

Lines of Electric or Magnetic Flux. Lines drawn through points in an electric or magnetic field in the direction of the flux at these points.

Lines of Force and Lines of Induction. These may be either magnetic or electrostatic, and are curves drawn, through a magnetic or electrostatic field or round a magnetic circuit, so that the tangent at any point on their length gives the direction of the resultant electric or magnetic force, or induction, respectively at that point. The sides of *Tubes of force* are formed by lines of force, but the terms are also used some-

what loosely for unit tubes of force and induction. The term *Lines of Force* is sometimes restricted to the part of the magnetic circuit outside the iron, while "lines of induction" is used for the portion within the iron. See **LINE, KILO-LINE, MAXWELL, GAUSS, FARADAY TUBE, and MAXWELL TUBE.**

Lines of Induction. See **LINE OF FORCE.**

Linesman's Detector. A simple form of galvanometer, usually with a needle pivoted in a horizontal plane, for detecting the presence of a current in a circuit, for rough testing purposes.

Lining, Slot. See **SLOT LINING.**

Link. (1) A solid removable connection, usually a flat strip fixed by bolts only to be disconnected when the circuit is dead. (2) In automatic telephony, a wire connecting selectors, etc., in an exchange.

Link : Disconnecting, Fuse, Isolating, and Wireless. See **DISCONNECTING LINK, FUSE LINK, etc.**

Link Insulator. A form of porcelain insulator for high-pressure lines, etc., capable of being used in chains of several units in series as a suspension or strain insulator; usually constructed so that the porcelain is only subjected to compressive stress, and so that breakage of the porcelain does not release the conductor.

Linkage. Magnetic flux is said to "link" a circuit when it is embraced by closed loops of that circuit. The total linkage of lines through a coil or solenoid (if there is no magnetic leakage) is the flux passing through the solenoid multiplied by the number of turns. Any alteration in the linkage of lines produces an e.m.f.

Linked Switch. Two or more single pole switches with their handles joined together by a cross bar or otherwise so as to be operated simultaneously or in a predetermined sequence.

Links, Disconnecting or Isolating. See **ISOLATORS.**

Lippmann Electrometer. A form of *Capillary Electrometer.*

Liquid Brush Converter or Rectifier. A form of *Commulator Rectifier*

with brushes consisting of jets of mercury playing on the commutator.

Liquid Controller or Starter. A *Liquid Rheostat* adapted for the starting or speed control of a motor.

Liquid Insulation. Oils, etc., used for the insulation of transformers, switches and other high tension apparatus. The dielectric strength of such oils depends largely upon the absence of moisture and suspended solid impurities.

Liquid-Quenched Cut-Out or Fuse. A cut-out in which the arc is quenched by a liquid. See **IMMERSED and SEMI-IMMERSED LIQUID-QUENCHED CUT-OUTS.**

Liquid Resistor. A *Resistor* consisting of a conducting liquid, such as water with the addition of sulphuric acid or of caustic soda, to and from which the current is taken by metal plates immersed in the liquid; used in cases where a compact and cheap variable resistance is required, as for absorbing heavy loads in testing generating plant, or where continuous variation of the resistance is required as in *Dimmers* for theatre lighting, etc. See **LIQUID RHEOSTAT, LIQUID STARTER, ARTIFICIAL LOAD, etc.**

Liquid Rheostat. A *Liquid Resistor* in which the value of the resistance can be continuously varied by raising and lowering the plates, etc., immersed in the liquid, or by varying the amount of liquid in contact with the electrodes by altering its level by a pump or otherwise.

Liquid Starter. See **LIQUID CONTROLLER.**

Lissajous Figures. Any closed figures traversed by a point moving with the resultant of two periodic oscillatory motions at right angles. Originally applied to certain experiments in connection with pendulums and sound, but now used for a class of records of this nature by such instruments as the *Cathode Ray Oscillograph.* See also **CYCLOGRAPH.**

Listening Key. A key on a telephone switchboard by means of which

- an operator connects her head set to a line, to communicate with the calling subscriber or to ascertain if a line is in use.
- Lithanode.** A specially prepared hard and compact form of lead peroxide for accumulator plates.
- Litzendraht or Litz Wire.** Wire made up of fine separately insulated strands to offer low resistance to high frequency currents.
- Live.** See **ALIVE**.
- Live Conductor.** A conductor connected to a source of e.m.f.; usually applied to a conductor at a high difference of potential from the earth.
- Live Rail.** The conductor rail on a third rail traction system at a potential above that of the earth, as distinct from a rail at approximately earth potential carrying the return current, or the running rails.
- Load.** (1) The output (kilowatts) that a generating plant is being called upon to give at any time, or the horse-power which is being exerted by an electric motor. (2) Inductance added to a telephone or wireless circuit. See **LOADING**.
- Load : Artificial, Balanced, Condensive, Connected, Full, Inductive, Lagging, Leading, Light, Lighting, Non-Inductive, Non-Reactive, Off-Peak, Out-of-Balance, Peak, Power, Reactive, Symmetrical, Traction, and Unbalanced.** See **ARTIFICIAL LOAD, BALANCED LOAD, etc.**
- Load Curve.** A curve made by plotting the load in kilowatts against time, to show its variation at different times of the day, seasons of the year, etc.
- Load Despatcher.** An official in a special office connected by telephone to all parts of a large power distribution system, traction system, etc., who is responsible for the distribution of the load in various parts of the system according to requirements.
- Load Factor Rating.** The rating of motors, etc., for intermittent working according to the load that they can carry at a given load factor; used particularly in connection with crane motors, etc.
- Load Levelling Relay.** A relay used in domestic and other installations for automatically switching off such appliances as water heaters when the general demand exceeds a certain value and connecting them to the circuit again when it drops below that value.
- Loaded Aerial.** An *Aerial* provided with extra inductance, with or without extra capacitance, to increase its wave-length. See **LENGTHENING COIL**.
- Loaded Cable.** A cable, such as a submarine telephone cable, provided with extra inductance to counteract the effect of its capacitance and thus to diminish attenuation. See **LOADING COIL, CONTINUOUS LOADING, etc.**
- Loaded Circuit or Line.** A telephone circuit containing extra inductance to improve its transmission efficiency. See **LOADING COILS, etc.**
- Loading.** The addition of inductance to telephone lines or cables to counteract the effect of capacitance in order to diminish *Distortion*. See also **SPECIFIC UTILISATION COEFFICIENTS**.
- Loading : Coil, Continuous, Inductive.** See **COIL, LOADING, CONTINUOUS LOADING, etc.**
- Loading Coil.** (1) An inductance coil with an iron core for insertion in a telephone line or cable to lessen the effect of its capacitance and to reduce distortion. (Also called *Pupin Coil*.) (2) Inductance added to a wireless aerial.
- Loadstone.** See **LODESTONE**.
- Lobes (Electric).** The part of the medulla in *Electric Fishes* which controls their *Electric Organs*.
- Local Action.** Local electrolytic action on the surface of an electrode in a primary or secondary cell due to impurities and causing the gradual dissolving away of the electrode.
- Local Battery.** A battery in a local circuit such as that opened and closed by a telegraph *Relay*.
- Local Battery Telephone System.** A system employing a battery at the subscriber's station to provide the speaking current. Cf. **CENTRAL BATTERY SYSTEM**.
- Local Circuit.** An auxiliary circuit

connected by a relay or otherwise to the main circuit.

Local Oscillations. Oscillations in a wireless receiving circuit due to the action of the apparatus itself, e.g. from a separate oscillator valve for heterodyne reception, or due to self oscillation.

Local Oscillator. An oscillator producing auxiliary oscillations to obtain a heterodyne effect.

Localisation of Faults. The ascertaining of the approximate position of a fault on a cable or line by measurements of resistance through the fault, etc. See **LOOP TEST**, **RAPHAEL BRIDGE**, etc.

Lock, Magnetic. See **MAGNETIC LOCK**.

Locked Coil Conductor. A stranded conductor in a cable, the section of the outer wires of which is such that they lock together to resist radial movement.

Locked Cover Switch. A *Branch Switch* which can only be actuated by unlocking a cover with a key.

Looking Lampholder. A lampholder arranged so that the incandescent lamps cannot be withdrawn from it except by persons in possession of a special key or tool, or knowing the secret of its construction.

Looking Switch. See **LOOKED COVER SWITCH**.

Locomotive (Electric). A locomotive for drawing passenger or goods trains or other vehicles on electric railways; used in preference to trains with motors on the cars particularly for freight traffic, for high voltage main lines and for drawing trains normally drawn by steam locomotives over special stretches of line such as those through long tunnels.

Locomotive: Accumulator, Articulated, Direct Current, Diesel-Electric, Geared, Gearless, Mining, Motor-Generator, Side-Rod, Single-Phase, Three-Phase, and Turbo-Electric. See **ACCUMULATOR LOCOMOTIVE**, **ARTICULATED LOCOMOTIVE**, etc.

Lodestone (or Loadstone). The mineral magnetite (Fe_3O_4) found in various parts of the world in a naturally magnetised state; so called as being a "leading" stone due to its property of setting itself

north and south when freely suspended. See **MAGNET**. The directive power of the lodestone and of magnets made from it was not known in Europe until about the twelfth century, although it appears to have been used by the Chinese about a thousand years before.

Lodestone, Armed. See **ARMED LODESTONE**.

Lodge Coherer or Detector. A *Coherer* in which the variable contact is between a point and a metal plate. (Named after Sir Oliver Lodge.)

Lodge Valve. A rectifying discharge tube, with a gas pressure of about one millionth of an atmosphere, with one coiled and one plate electrode in a special bulb arranged so that it is only when the plate electrode is the cathode that the projected electrons reach the anode and cause a current to pass.

Lodge-Muirhead Detector. A *Coherer* with a variable contact between mercury and a steel wheel under oil.

Lodge-Muirhead System of Wireless Telegraphy. An early system distinguished principally by the use of accurately tuned sending and receiving aërials with symmetrical upper and lower capacitance areas with no earth connection, and a multiple spark gap in the aerial circuit.

Loftin-White Circuit. A circuit for wireless reception in which electrostatic, as well as electromagnetic, coupling is used to produce resonance. This makes the reactive effect practically independent of the frequency.

Logarithmic Decrement and Increment. The logarithm of the ratio of the amplitudes of two successive waves of a periodic function, like a series of electrical oscillations, which are diminishing or increasing in geometrical progression. Cf. **LINAL DECREMENT**. Symbol: δ

Logarithmic Decrement and Increment, Equivalent. See **EQUIVALENT LOGARITHMIC DECREMENT AND INCREMENT**.

Logarithmic Horn. A horn for a loud speaker in which the diameter varies as the length, according to a logarithmic law.

Long Chord Winding. A *chord Winding* in which the back pitch is one slot less than an exact multiple of the number of poles, i.e. where one tooth separates the coil sides [short-circuited by a brush in each zone. Cf. **SHORT CHORD WINDING**.

Long Distance (Telephone) Line. See **TRUNK CIRCUIT**.

Long Pull Magnet. An electromagnet with its magnetic circuit so arranged that it can exert a practically uniform pull over a considerable range of movement of its armature, by a conical plunger moving in a hollow core or otherwise.

Long Shunt Compound Winding. A compound field winding in a dynamo where the shunt winding is connected across the external terminals, i.e. on the load side of the series field winding. Cf. **SHORT SHUNT**.

Long Waves. A term formerly in common use for wave-lengths over 1,000 metres, but lately limited by the International Radio-technical Committee to waves over 3,000 metres (below 100 kc.).

Longitudinal Voltage. A term used in connection with *Interference* in communication circuits for a voltage induced between different parts of the same line, or between a conductor and earth. Cf. **TRANSVERSE VOLTAGE**.

Loop. (1) In a wireless direction finder: one of the two aerial systems used at right angles to each other. (2) See **ANTINODE**. (3) Of an armature coil: the sharp bend at the end of the end connection portion particularly in a *Former Wound Coil*.

Loop: Hysteresis and Subscriber's. See **HYSTERESIS LOOP** and **SUBSCRIBER'S LOOP**.

Loop Aerial. Originally a receiving aerial composed of a large rectangle of wire, similar to a *Frame Aerial* of one turn, used particularly in *Wireless Direction Finding*. Now used for a frame aerial generally.

Loop Dialling. A system of *Dialling* in automatic telephony employing

Break Impulses in a loop or double metallic circuit.

Loop Galvanometer. A very sensitive galvanometer in which a U-shaped current-carrying loop of aluminium foil forms the moving part. The two limbs of the loop are in magnetic fields of opposite directions, and the movement is observed through a microscope.

Loop Test. A fault localisation test in which a sound line or cable is connected to the far end of the cable under test to complete the circuit or loop back to the testing point.

Loop Test: Allen's, Varley's, and Murray's. See **ALLEN'S LOOP TEST**, **VARLEY'S LOOP TEST**, etc.

Loop Tuning Error (of Wireless Direction Finders). Inaccurate reading caused by differences in the natural frequencies of the two loops.

Looped Filament. A carbon incandescent lamp filament arranged partly in a helix of one or more turns to enable the required length to be contained in a bulb of reasonable proportions and to improve the distribution of light. Cf. **HORSESHOE FILAMENT**.

Looping In. A method of arranging interior wiring or connecting up cables, in which cutting of the wire or cable at every point where a connection is made is avoided, by bringing it up to the terminal, etc., doubling it back on itself and taking it on to the next point. By this means, although more wire is required, the making of a large number of joints is avoided. The term is also applied to the connection of feeders to sub-stations, etc., independently of whether the cable is cut or not, when the feeder proceeds on its route to another sub-station, or to complete a ring so that a supply may be maintained from either direction.

Loose Coupler. Apparatus for effecting a *Loose Coupling*, e.g. by two coils sliding one over the other.

Loose Coupling. Coupling of two circuits where the coupling factor is low, e.g. inductive coupling where there is considerable magnetic leakage.

Loose Key Switch. See DETACHABLE KEY SWITCH.

Lorentzen Furnace. See BURIED HEARTH ELECTRODE FURNACE.

Lorenz Apparatus. An apparatus for the absolute determination of the value of a resistance by rotating a metal disk in the uniform field produced by a current in a coil of accurately known dimensions and balancing the e.m.f. thus produced between its centre and its circumference against the drop of potential produced by the same current in the resistance to be measured.

Lorimer Automatic Telephone System. An early automatic telephone exchange system distinguished by the use of power-driven line selectors instead of selectors actuated by the calling current impulses.

Loss. The amount of energy which for any reason does not re-appear in a machine or apparatus in a form suitable for useful work is termed a "loss." Thus the output is equal to the input minus the sum of the losses. See EFFICIENCY.

Loss(es): Band, Brush Friction, Commutator, Copper, Core, Corona, Eddy Current, Energy, Excitation, Friction, Head End, Hysteresis, I^2R , Iron, Line, Meter, No Load, Ohmic, Open Circuit, Reflection, Resistance, Rheostatic, Stand-by, Stray Load, and Windage. See BAND LOSSES, BRUSH FRICTION LOSS, etc.

Loss Angle (of a Dielectric). The angle δ by which the phase displacement (lead) of the current through a capacitor falls short of a right angle owing to imperfection of the dielectric causing a power loss of $E I_{eff} \delta$.

Loss Coefficient. A term sometimes used in dealing with the economies of power consumption of motors or other consuming apparatus, for $(1/\text{efficiency}) - 1$.

Loss of Charge. The gradual dissipation of the charge of an electrically charged body due to leakage, etc. With constant leakage, the rate of diminution of the charge follows a logarithmic law. (The potential after a time

t being $V_0 e^{-bt}$ where V_0 is the original potential and b a constant, called the *coefficient of leakage*, which depends upon the state of the surface, the humidity and composition of the surrounding gas, its degree of ionisation and the presence or absence of ultra-violet light.)

Loss of Charge Method. A method of measuring very high insulation resistances by observing the rate of loss of charge of a condenser connected across the points between which the resistance is to be measured.

Loud Speaker. A receiver for wireless or line telephony of sufficient power to be heard from some distance, either provided with a horn or its equivalent, or a specially arranged large vibrating surface.

Loud Speaker: Balanced Armature-Coil-Driven, Cone, Dynamic, Glow, Hornless, Inductor, Moving Coil, Permanent Magnet Moving Coil, and Reed. See BALANCED ARMATURE LOUD SPEAKER, COIL-DRIVEN LOUD SPEAKER, etc.

Low Definition Television. Television in which the number of scanning lines to the picture is under 100.

Low Frequency Amplification. See AUDIO-FREQUENCY AMPLIFICATION.

Low Frequency Resistance. A term sometimes used for ordinary ohmic resistance at frequencies where skin effect, etc., is negligible and the resistance is practically the same as for direct current.

Low Frequency Transformer (Wireless). A transformer for audio-frequencies. See also INTERVALVE TRANSFORMER.

Low Pass Filter. A Wave Filter which prevents the passage of oscillations above a certain frequency.

Low Power Modulator. A Choke Modulator in which the modulating valve controls the oscillations before their amplification to full power. Cf. HIGH POWER MODULATOR.

Low Pressure. The official Board of Trade description of a voltage below 250 volts, between any two

- conductors or between one conductor and earth. Cf. MEDIUM, HIGH and EXTRA HIGH PRESSURE.
- Low Resistance Bridge.** A *Wheatstone's Bridge* or similar apparatus arranged to be suitable for the measurement of low resistances, e.g. *Kelvin Bridge*, *Carey Foster Bridge*, etc.
- Low Tension (L.T.)** A general expression for low voltage without any definite limits, used particularly where distinction is to be made between circuits of different voltages. Cf. LOW PRESSURE.
- Low Tension Battery.** A battery for supplying current to the filaments of thermionic valves.
- Low Tension Detonator.** A detonator for electrical shot firing ignited by a wire heated by an electric current. Cf. HIGH TENSION DETONATOR.
- Low Tension Ignition.** Electric ignition in internal combustion engines in which the spark is produced by mechanically breaking a current-carrying circuit, inside the cylinder, at the proper time.
- Low Tension Magneto.** A magneto generator for supplying the current impulses required in low tension ignition. Cf. HIGH TENSION MAGNETO.
- Low Voltage.** See LOW TENSION.
- Low Voltage Circuit-Breaker, Relay, etc.** See UNDER-VOLTAGE CIRCUIT BREAKER, etc.
- Lower Capacitance or Lower Capacitance Net.** See COUNTERPOISE.
- Lower Hemispherical (Luminous) Flux.** The flux emitted by a light source below a horizontal plane through its centre. Cf. UPPER HEMISPHERICAL FLUX.
- Lower Side Band.** A *Side Band* composed of frequencies below the carrier wave frequency.
- L.T.** Abbreviation for *Low Tension*.
- "L" Type Aerial.** See INVERTED "L" TYPE AERIAL.
- Lug (of an Accumulator Plate).** The projecting portion to which connection is made.
- Lug, Commutator.** See COMMUTATOR LUG.
- Lumen.** The unit of luminous flux, defined as the luminous flux emitted per unit solid angle (steradian) by a uniform point source of a luminous intensity of one *International Candle*.
- Lumeter.** A form of portable illumination photometer in which the illumination of the comparison surface by the standard lamp is controlled by a variable aperture.
- Luminaire.** A term used in America for an *Electric Light Fitting*.
- Luminance.** A term proposed for the quantitative expression of *Brightness*.
- Luminescence.** Emission of visible radiation due to causes other than high temperature, e.g. the glow in *Discharge Tubes*, etc., *Fluorescence* and *Phosphorescence*.
- Luminescence Lamp.** See DISCHARGE LAMP.
- Luminosity Factor.** The ratio of *Luminous Flux* emitted at a given wavelength to the energy flux. Symbol: *K*.
- Luminous Arc Lamp.** Another name for *Flame Arc Lamp*.
- Luminous Efficiency.** The percentage or the total energy absorbed by a light giving apparatus given out as visible radiation.
- Luminous Flux.** The name given to the rate at which energy in a visible luminous form is being radiated by a source of light; therefore, in rough language, the "quantity" of light being emitted. Symbol: *L*. See LUMEN.
- Luminous Gas Lamp.** See GAS DISCHARGE LAMP.
- Luminous Intensity.** *Luminous Flux* emitted per unit solid angle. Symbol: *I*. See also CANDLE POWER.
- Lummer-Brodhun Photometer.** A *Contrast Photometer*, in which an arrangement of prisms enables portions of the two surfaces illuminated by the source under test and the standard source to be viewed in juxtaposition, with portions of each apparently surrounded by the other.
- Lumped Characteristic (in a Thermionic Valve).** The characteristic showing the relation between *Lumped Voltage* and *Plate Current*.
- Lumped Voltage (in a Thermionic Valve).** The anode voltage which would have to be applied when a certain grid voltage is present to

bring the anode current back to its valve for zero grid voltage.

Lunar Currents. Diurnally varying currents in the upper strata due to tidal movements of conducting portions of the atmosphere relatively to the magnetic field of the earth due to lunar attraction.

Lux. A unit of *Illumination*, being the illumination of a surface receiving one lumen per square metre, i.e. that given by one candle power at a distance of one metre on a surface at right angles to the rays. (Also called *Metre-Candle*.) (One FOOT-CANDLE equals 10.764 lux.)

Luxemburg Effect. The transfer of the effect of modulations of the waves sent out from a powerful wireless transmitter to the carrier wave of another station of different frequency passing through the same region of the atmosphere, causing signals of the former station to be distinctly audible during reception of the latter.

Luxmeter. A form of *Illumination Photometer*, on the contrast principle, employing a variable aperture.

Luxometer. An improved form of the *Trotter* portable illumination *Photometer*.

[M.]

M. Symbol for *Mutual Inductance*.

m.A. Abbreviation for *Milliampere*.

Macheth Illuminometer. See **ILLUMINOMETER**.

Machine. A term somewhat loosely employed in electrical engineering usually to signify an apparatus with moving parts for converting mechanical into electrical energy or *vice versa*; such as a generator, or a motor, acting either on electromagnetic or electrostatic principles, but not including stationary apparatus, such as transformers.

Machine: Bonetti, Composite, Cylinder, Dynamo-Electric, Electrostatic, Frictional, Holtz, Hydro-Electric, Impulse, Induction, Influence, Lemstrom, Paying Out, Picking Up, Pidgeon, Plate, Toepler, Toepler-Holtz, Tudsbury, Voss, Wimshurst, and Wommelsdorf. See **BONETTI MACHINE**, **COMPOSITE MACHINE**, etc.

Machine Ringing. Telephone ringing by interrupted current from a power-driven generator started by a key or relay and stopped by a relay on the called party lifting his receiver.

Machine Switching (Telephone) System. See **AUTOMATIC TELEPHONE SYSTEM**.

Machine Telegraph Systems. An expression usually comprising such printing and other telegraph systems as involve the synchronous running of mechanisms at the sending and receiving stations.

Magazine Arc Lamp. An *Arc Lamp*, provided with a store of carbons, which come into action successively as they burn away, so that the lamp can burn for a long period without attention.

Magne-Crystalline Action. Phenomena due to the inequality of the magnetic susceptibility of some crystals along different axes. Closely allied to their optical properties.

[Mag]

Magnet. A mass of iron or other "magnetic" material, in a special condition of internal structure such that it exerts attraction or repulsion on other magnets presented to it, attracts other pieces of magnetic material, produces a "magnetic field" in the surrounding space wherein all magnets tend to set themselves in a particular direction and produces forces upon neighbouring circuits carrying currents, and electromotive forces in conductors moving relatively to the field. The term includes both *Electromagnets* in which the condition is produced and maintained by surrounding currents and *Permanent Magnets* in which the condition has already been set up by a field no longer present. The name originated from the *Lodestone*, the earliest known natural magnet having been found in Magnesia in Asia Minor.

Magnet: Artificial, Bar, Brake, Compound, Control, Damping, Electro-, Field, Gold, Horseshoe, Ironclad, Lamellar, Laminated, Lifting, Long-Pull, Natural, Permanent, Relay, Temporary, Throttle, and Tractive Power of. See **ARTIFICIAL MAGNET**, **BAR MAGNET**, etc.

Magnet Coil. Any coil carrying the current that excites an electromagnet, e.g. the field coils of a generator or motor.

Magnet Core. The iron portion of an electromagnet within the coil.

Magnet Frame. The external stationary portion of a direct current machine carrying the field magnet poles.

Magnet Pole. The part of a magnet where a group of lines of force enter or leave the iron and its forces of attraction and repulsion are concentrated. See **POLE**.

Magnet Steel. Special steel of high retentivity for the construction of permanent magnets; usually

containing tungsten, cobalt, chromium, manganese, or more than one of these elements.

Magnet Wheel. The rotating portion of a revolving field alternator, in the case of slow speed machines of large diameter where a ring of poles are bolted on to the rim of a flywheel.

Magnet Winding. See FIELD WINDING, MAGNET COIL, etc.

Magnet Wire. Insulated wire for the construction of magnet coils. See COTTON COVERED WIRE, SILK COVERED WIRE and ENAMEL WIRE.

Magnet Yoke. See YOKE.

Magnetarium. An old-fashioned name for a piece of apparatus in which the distribution of the earth's magnetism is imitated by an electromagnet system.

Magnetic. (1) Adjective; having magnetic property or pertaining to magnetism. (2) Noun (practically obsolete); a body capable of showing the phenomena of magnetism.

Magnetic Adhesion. The adhesive force between magnetised bodies in contact with each other due to magnetic attraction.

Magnetic Anisotropy. An inequality in *Susceptibility* in different directions developed in iron, etc., under mechanical stress.

Magnetic Ageing. See AGEING.

Magnetic Alloys. See HEUSLER ALLOYS, HYPERNIK, MUMETAL, PERMALLOY, and PERMINVAR.

Magnetic Amplifier. Any form of amplifier depending upon the properties of ferro-magnetic materials.

Magnetic Attraction. The mechanical force tending to draw together two magnetic poles of unlike polarity, including the case where the second pole is induced by the first as in the attraction of a magnet for a previously unmagnetised piece of magnetic material. Cf. MAGNETIC REPULSION.

Magnetic Axis. A line through the effective centres of the poles of a magnet. Used more particularly in theoretical considerations of magnets assumed to have their poles concentrated at points. See POLES.

Magnetic Battery. An old-fashioned expression for a *Compound* or *Laminated Permanent Magnet*.

Magnetic Bearing. A compass bearing taken with a magnetic compass uncorrected for *Declination*.

Magnetic Blow-Out. An arrangement for producing a concentrated field at the point where the circuit in a switch, controller, etc., is opened, to deflect the arc and extinguish it or "blow it out" rapidly.

Magnetic Blow-Out Fuse. A fuse arranged so that the arc produced by the breaking of the circuit on the fusing of the wire is blown out by a magnetic field produced by the current.

Magnetic Brake. A brake for vehicles, trains, etc., for absorbing power for testing, or to give a retarding torque in meters, etc., employing a braking force derived directly or indirectly from magnetic attraction or the reaction of eddy currents, etc. See EDDY CURRENT BRAKE, ELECTRO-MAGNETIC BRAKE, ELECTROMECHANICAL BRAKE, etc.

Magnetic Bridge. A magnetic testing apparatus in which magnetic fluxes are balanced in a similar manner to the balancing of currents in the *Wheatstone's Bridge*. See PERMEABILITY BRIDGE.

Magnetic Chart. A chart showing the distribution of the earth's magnetism by *Isoclinic* and *Isogonal Lines*, etc.

Magnetic Chuck. An appliance for holding work in lathes, etc., magnetically; usually consisting of a face-plate of which different parts, separated by non-magnetic material are oppositely magnetised by an embedded coil.

Magnetic Circuit. The closed path, usually partly through iron and partly through air, taken by the magnetic flux in a machine or an apparatus. See RELUCTANCE.

Magnetic Circuit: Closed, Divided, Double, Imperfect. See CLOSED MAGNETIC CIRCUIT, DIVIDED MAGNETIC CIRCUIT, etc.

Magnetic Clutch. A friction clutch for coupling shafts, etc., in which

the force between the friction surfaces is provided, when required, by an electromagnet forming part of the apparatus.

Magnetic Cohesion. See MAGNETO COHESION.

Magnetic Coition. The name given by Gilbert, and the early writers, to mutual magnetic attraction.

Magnetic Compass. A compass in which the directive power is that of a magnetic needle in the earth's field. Cf. GYROSTATIC COMPASS.

Magnetic Component (Of Electric Waves). See ELECTROMAGNETIC COMPONENT.

Magnetic Continuity. The property of a joint in a magnetic circuit whereby it offers a path of good permeability. Cf. MAGNETIC DISCONTINUITY.

Magnetic Control. The arrangement of instruments with a controlling force provided by a magnetic field. See INSTRUMENT CONTROL.

Magnetic Couple. The torque exerted by a uniform field on a pivoted magnet proportional to the strength of field, the sine of the angle which the needle makes with its direction and the *Magnetic Moment* of the needle.

Magnetic Creeping. A gradual increase in the intensity of magnetisation of a piece of iron after the magnetising force has been applied for some time. See VISCOUS HYSTERESIS.

Magnetic Curves. Curves showing the relation between the magnetisation produced in a piece of magnetic material and the magnetising force producing it. See MAGNETISATION CURVE, HYSTERESIS CURVE or LOOP, REVERSAL CURVE, SATURATION CURVE, etc.

Magnetic Cut-Out. A *Circuit-Breaker* actuated electromagnetically; usually confined to the smaller types of such apparatus.

Magnetic Cycle. See CYCLE OF MAGNETISATION.

Magnetic Damping. (1) Checking the oscillations of the moving system of instruments by the reaction of eddy-currents induced in a disc by a permanent magnet. (2) Damping oscillations which

have been set up in a resonating circuit by including magnetic material in the circuit, in which energy is dissipated by hysteresis.

Magnetic Declination. See DECLINATION.

Magnetic Detector. An expression occasionally used for a simple galvanometer (see LINESMAN'S DETECTOR), or for an instrument on the principle of the *Induction Balance* for revealing the presence of magnetic substances, but usually meaning a detector of electrical oscillations, used as a wireless telegraph receiver, depending on alterations produced in the magnetisation of iron, e.g. the Marconi Magnetic Detector in which changes produced in the magnetisation of a travelling band of steel are made to affect a telephone, by means of a search coil through which the band passes.

Magnetic Dip. See DIP.

Magnetic Discontinuity. An airgap in a magnetic circuit or a layer of non-magnetic material introduced accidentally, or for such a purpose as to prevent a relay armature, etc., coming in actual magnetic contact with a pole so that it releases itself more easily.

Magnetic Dispersion. See DISPERSION. The leakage flux in a machine, i.e. the flux which does not link both armature and field (or both rotor and stator) windings.

Magnetic Drum Recorder. A recording telegraph receiver for cable circuits, in which deflection of the pen is effected by *Magneto-Cohesion*, as in a ROTATING DRUM RELAY.

Magnetic Drum Relay. See ROTATING DRUM RELAY.

Magnetic Elements. (1) The three elements, iron, nickel, and cobalt showing magnetic qualities in a marked degree. (2) The three quantities which completely define the magnetic field due to the earth at any point, viz., *Declination*, *Inclination* and *Horizontal Component*.

Magnetic Elongation. The slight increase in length of an iron wire, etc., produced by magnetising it.

Magnetic Equator. The region, either

in terrestrial magnetism or in the field of an ordinary magnet, where the attraction of the North and South Poles balances.

Magnetic Fatigue. An expression used to signify the deterioration of transformer iron after long continued use, when it was thought that this was due to the continued repetition of cycles of magnetisation and not to prolonged moderate heating. See AGEING.

Magnetic Field. A region through which magnetic flux passes. Generally used for such space outside the iron of a magnetic circuit or where there is no iron. Also used to mean the strength of such a field expressed in lines of force per unit area of cross-section.

Magnetic Field Intensity or Strength. See MAGNETISING FORCE; and Cf. INTENSITY OF MAGNETISATION.

Magnetic Figures. The groups of curves showing the distribution of a magnetic field made by sprinkling iron filings on a surface in the field.

Magnetic Flux. The total amount of that magnetic property which may be conceived as flowing from one pole of a magnet to the other or around electric currents, the alteration in quantity of which, linking a conducting circuit, causes the development of an e.m.f. Symbol: ϕ . See MAXWELL, and also FLUX DENSITY.

Magnetic Flux Density. See FLUX DENSITY.

Magnetic Foot. Points on the earth's surface where the *Horizontal Component* of the earth's magnetic field reaches maxima or minima.

Magnetic Focusing (in a *Cathode Ray Tube*). See FOCUSING COIL.

Magnetic Force. See MAGNETISING FORCE.

Magnetic Friction. The strong friction between two surfaces of iron, etc., drawn into contact magnetically.

Magnetic Furnace Regulator. A regulator for electric furnaces depending upon the loss of magnetisation in an iron core when a certain temperature is reached.

Magnetic Hysteresis. See HYSTERESIS.

Magnetic Inclination. See INCLINATION.

Magnetic Induction. (1) The act of "inducing" poles in a piece of magnetic material by the field due to a neighbouring magnet.

(2) See FLUX DENSITY.

Magnetic Inductive Capacity, or Magnetic Inductivity. Terms occasionally used for *Permeability*.

Magnetic Instability. The condition in a shunt wound machine if the external circuit has such a *Critical Resistance* that a slight diminution in its value will cause the machine to fail to maintain its excitation. (2) The condition of relation between the magnetic nuclei of the atoms of a magnetic substance, according to the Ewing theory of magnetisation when the magnetising force is just sufficient to deflect them to an extent that they break up their original mutual groupings.

Magnetic Insulation. Strictly speaking, there is no such thing as "magnetic insulation," as the lines of force can pass through any medium, but the term is occasionally met with as meaning the interruption of the iron, etc., of a magnetic circuit by an air-gap or non-magnetic material.

Magnetic Intensity. See INTENSITY OF MAGNETISATION.

Magnetic Joint. A joint in the magnetic material of a magnetic circuit.

Magnetic Lag. See VISCOUS HYSTeresis and MAGNETIC CREEPING.

Magnetic Latitude. Latitude measured with relation to the magnetic poles of the earth instead of the geographic poles.

Magnetic Leakage. The passage of magnetic flux through the air outside the useful path in a magnetic circuit of a machine, etc., where it is required. See references under LEAKAGE.

Magnetic Lens. An expression sometimes used for an *Electromagnetic Lens*.

Magnetic Limit. See LIMITS OF INDUCTION.

Magnetic Lines of Force. See LINES OF FORCE.

Magnetic Linkage. See LINKAGE.

Magnetic Lock. A locking device on a miner's safety lamp, whereby the lamp can only be opened by the presence of a powerful electro-magnet.

Magnetic Map. A map showing the distribution, etc., of the earth's magnetism by *Isoclinic* and *Iso-gonal Lines*, etc.

Magnetic Meridian. A plane passing through a particular point on the earth's surface and the magnetic poles; determined by the direction assumed by a magnetic needle at that point.

Magnetic Model. A model such as the groups of magnets used by Ewing to demonstrate the mutual action of the rotatable magnetic portions of atoms so as to account for the phenomena of hysteresis, etc., or his later model of the atom, showing the effect of the control of the fixed portion upon the moving portion.

Magnetic Modulator. A *Modulator* for wireless transmitting stations in which the variations of the microphone current cause changes in the inductance of iron-cored coils in a circuit in parallel with the aerial inductance. No amplifying valves are employed.

Magnetic Moment. The ratio of the maximum torque exerted on a magnet to the magnetic force of the field in which it is situated; also defined as the product of the strength of pole of a magnetic needle or other magnet and the distance between its poles; upon which the torque exerted upon it by a magnetic field depends. See MAGNETIC TORQUE.

Magnetic Needle. A small balanced pivoted magnet with freedom of angular movement.

Magnetic North. The direction in which the "North" pole of a magnetic needle points, i.e. the direction of the magnetic meridian at any place. Differing from true geographic North by a variable angle called the *Declination*.

Magnetic Ore Separator. See MAGNETIC SEPARATOR.

Magnetic Oscillations. Variation of flux in generators, etc., due to the passage of individual teeth of

the armature under the poles causing ripples in the e.m.f. produced. See TOOTH RIPPLES.

Magnetic Oxide of Iron. Peroxide of Iron (Fe_2O_4), the chief ingredient of *Magnetite*.

Magnetic Parallels. Lines on a magnetic map of equal *Vertical Component* of the earth's magnetism. (Sometimes called lines of *Magnetic Latitude*.)

Magnetic Path. The course followed by the lines of force in a magnetic circuit. See RELUCTANCE.

Magnetic Permeability. See PERMEABILITY.

Magnetic Plug. An ignition plug for a system of low tension ignition in which the circuit is broken within the cylinder by the action of an electromagnet, forming part of the plug, as soon as the current is established.

Magnetic Pole. See POLE.

Magnetic Pole Strength. See POLE STRENGTH.

Magnetic Potency. A name suggested for the quality in steel for permanent magnets whereby it requires great *Coercive Force* to remove its magnetisation.

Magnetic Potential. A conception similar to *Electric Potential* defined, in the theory of the magnetic field, as the work done in carrying a unit pole from a point where there is no magnetic field to the point in question. The difference of magnetic potential, i.e. the work done in carrying a unit pole between two points is, in practice, called *Magnetomotive Force*.

Magnetic Proof Plane. A name sometimes given to a small *Exploring Coil*.

Magnetic Properties of Iron or Steel. The magnetic properties of iron or steel which determine its suitability for use in machines and transformers are its *Permeability* and *Hysteresis* at the induction at which it is likely to be used, while its *Retentivity* is the chief factor which decides its suitability for making permanent magnets.

Magnetic Pull. The attractive force

due to a magnet. See also UNBALANCED MAGNETIC PULL.

Magnetic Reactance. A name sometimes given to the component of *Reactance* due to *Inductance*, i.e. $2\pi fL$ (where f and L are the frequency and inductance respectively).

Magnetic Reluctance. See RELUCTANCE.

Magnetic Remanence. See REMANENCE.

Magnetic Repulsion. See REPULSION.

Magnetic Resistance. A term sometimes used for *Reluctance*.

Magnetic Resistance, Specific. See SPECIFIC MAGNETIC RESISTANCE.

Magnetic Retentivity. See RETENTIVITY.

Magnetic Rocks. Masses of rock of a magnetic nature, chiefly basalt, etc., which have a local effect on the compass.

Magnetic Saturation. See SATURATION.

Magnetic Screen. A screen or shield formed by a substantial layer of soft iron to protect an instrument from the effect of stray fields by affording a path of low reluctance to the lines of force.

Magnetic Separator. An apparatus in which small masses of magnetic material are separated from a mixture by an electromagnet which deflects them from the course taken by the non-magnetic portion of the mixture. Used for separating iron filings, turnings, etc., from brass, and the separation of magnetic from non-magnetic ores in a powdered state.

Magnetic Shell. A thin sheet of magnetic material conceived for theoretical purposes to be magnetised in a lamellar manner, i.e. with the poles formed by its entire front and back surfaces.

Magnetic Shield. See MAGNETIC SCREEN.

Magnetic Shunt. A piece of iron, usually adjustable in position, for diverting a proportion of the lines of force passing through an air-gap; sometimes used in a moving coil instrument to vary its sensitivity.

Magnetic Slot Wedge. A *Slot Wedge* or *Key* of magnetic material to

give the same effect as a *Closed Slot*.

Magnetic Sound Recording. See TELEGRAPHONE (1).

Magnetic South. The direction in which the "South" pole of a free magnetic needle points. See also MAGNETIC NORTH.

Magnetic Spectrum. See BETA (β) RAY SPECTRUM.

Magnetic Square. See EPSTEIN HYSTERESIS TESTER.

Magnetic Stability. The power of permanent magnets of resisting demagnetisation by outside influences, such as stray fields, vibration, etc.

Magnetic Storms. Sudden and irregular variations of the earth's magnetic field, possibly due to streams of electrons projected from the sun, sometimes sufficient to disorganise telegraph traffic, often accompanied by and possibly due to exceptional activity of sun spots, and sometimes associated with displays of *Aurora Borealis*.

Magnetic Strain Gauge. An instrument for the measurement of strains in rails, etc., depending upon the change of reluctance of a magnetic circuit with a movable armature.

Magnetic Substances. Substances showing magnetic properties; strictly speaking, including feebly magnetic (*Paramagnetic*) as well as strongly magnetic (*Ferro-magnetic*) substances.

Magnetic Survey. A survey for ascertaining the distribution of the earth's magnetism.

Magnetic Susceptibility. See SUSCEPTIBILITY.

Magnetic Tester. An instrument for measuring the *Permeability* or *Hysteresis* of samples of iron or steel. See DU BOIS BALANCE, HYSTERESIMETER (Blondel), HYSTERESIS TESTER (Ewing and Epstein), PERMEABILITY BALANCE, PERMEABILITY BRIDGE, PERMEAMETER, etc.

Magnetic Testing. The determination of the magnetic quality of iron, steel, or other substances. See BALLISTIC METHOD, BAR AND YOKE METHOD, DOUBLE BAR

AND YOKE METHOD, HOPKINSON METHOD, ISTHMUS METHOD, MAGNETOMETER METHOD, TRACTION PERMEAMETER, WATTMETER METHOD, and references under MAGNETIC TESTER and PERMEAMETER.

Magnetic Torque. The couple exerted on a magnetic needle by a field.

Magnetic Tubes of Force. See TUBES OF FORCE.

Magnetic Units. Units whereby magnetic quantities are measured. See AMPERE-TURN, GAUSS, GILBERT, LINE OF FORCE, MAXWELL, OERSTED, UNIT POLE, etc.

Magnetic Variation. See VARIATION.

Magnetic Viscosity. See VISCOUS HYSTERESIS and MAGNETIC CREEPING.

Magnetics. The science of magnetism.

Magnetisability. See SUSCEPTIBILITY.

Magnetisation. The act of rendering iron, steel, etc., magnetic; believed, according to the Ewing theory to consist in the orientation of rotatable and independently magnetic portions of each molecule, so that the lines of force from them are in the same direction and together produce a flux in addition to, and usually greater than, that of the extraneous field that originally caused this orientation.

Magnetisation : Ampère's Theory of, Anomalous, Circutual, Circular, Coefficient of, Cycle of, Ewing's Theory of, Flash, Intensity of, Lamellar, Poisson's Theory of, Solenoidal, and Weber's Theory of. See AMPÈRE'S THEORY OF MAGNETISATION, ANOMALOUS MAGNETISATION, etc.

Magnetisation by Divided, Double, and Single Touch. See DIVIDED TOUCH, etc.

Magnetisation Characteristic. A curve connecting the total flux and the ampere-turns of excitation of a dynamo-electric machine.

Magnetisation Current. See MAGNETISING CURRENT.

Magnetisation Curve. A curve showing the relation between magnetising force (H) and flux density (B) for a particular sample of iron or steel, etc., embodying results taken by the reversal or other method which avoids hysteresis effects.

Such a curve shows three more or less distinct stages : (1) The initial stage of moderate slope, i.e. where (B) increases slowly as (H) increases, (2) the steep portion where a large increase of (B) only requires a small increase in (H), and (3) beyond the *Knee* of the curve, a flatter portion asymptotic to a straight line where the only increase in (B) is that due to the external field (H) as the Intensity has reached its *Saturation Value* above which it cannot increase. (Also called *B-H Curve* or *Saturation Curve*.) A magnetisation curve can also be made by plotting intensity of magnetisation (J) against (H).

Magnetised Watch. A watch, the time keeping qualities of which have been impaired by introduction into a magnetic field due chiefly to magnetisation of the balance spring causing disturbing forces between its turns. See STRAY FIELD, DEMAGNETISATION OF WATCHES, and NON-MAGNETIC WATCH.

Magnetising Coil. Any coil of wire surrounding an iron core and carrying a current to magnetise it.

Magnetising Component. The component of an alternating current in quadrature with the c.m.f.; forming the greater part of the no-load current of a transformer or similar alternating current apparatus.

Magnetising Current. Used in general for the exciting current of a field or other magnet, and also in the sense above defined under MAGNETISING COMPONENT.

Magnetising Force. The "Force" which produces *Flux Density* at a point; measured by the mechanical force produced on unit pole in a vacuum at that point. The name *Oersted* is now adopted for the unit. The name "line" formerly used, is unsuitable as it is employed for other quantities. It can also be expressed in gilberts per cm., or, in the case of a field produced by a solenoid, in ampere-turns per cm. or inch. Symbol : H .

Magnetism. The property possessed by bodies of iron, steel and certain

other materials, when in a particular condition of internal structure, and of the space in the neighbourhood of electric currents or disturbances, of exerting mechanical force upon neighbouring masses of iron, etc., and of causing e.m.f.'s to be produced in conducting bodies moving relatively to such bodies or currents. Also the whole science of the phenomena due to this property.

Magnetism : *Animal, Blue, Charge of, Lamellar, Latent, Permanent, Quantity of, Red, Remanent, Residual, Rotary, Solenoidal, Sub-permanent, Terrestrial, and Vertiginous.* See ANIMAL MAGNETISM, BLUE MAGNETISM, etc.

Magnetite. The mineral, composed chiefly of magnetic oxide of iron (Fe_3O_4), which, when found in a magnetised condition, forms the *Lode-Stone* or natural magnet.

Magnetite Arc-Lamp. A form of *Flame Arc-Lamp* with a negative electrode made of a mixture of magnetite with small quantities of titanium and other oxides in an iron tube and a copper positive electrode. An arc of a very pure white colour is produced and the electrodes burn away much slower than is the case with carbon arc lamps. Cf. TITANIUM CARBIDE ARC-LAMP.

Magneto. Abbreviation for *Magneto-Generator*, used particularly for the special small forms of these machines employed for electric ignition, telephone bell ringing, and for firing explosives.

Magneto: High Tension and Low Tension. See HIGH TENSION MAGNETO and LOW TENSION MAGNETO.

Magneto Alternator. An alternator in which the field is provided by permanent magnets.

Magneto Bell. A telephone bell constructed to work with the current, usually alternating, from a magneto generator; with a vibrating armature which causes the hammer to strike two gongs alternately.

Magneto Compass. An aircraft compass similar to the earth inductor compass but with iron pole pieces in the earth-excited field circuit.

Magneto Exploder. A small *Magneto Generator* worked by hand for producing the current required for electric shot-firing. See also MINE EXPLODER.

Magneto Generator. A generator in which the field is provided by permanent magnets (see MAGNETO) confined almost entirely to small machines for special purposes. Large *Magneto-Alternators* were however formerly employed for arc lighting, particularly in light-houses.

Magneto Ignition. Electric *Ignition* in internal combustion engines, in which the current is supplied by a special magneto generator. See HIGH TENSION and LOW TENSION IGNITION.

Magneto Inductor. A name given to the early forms of magneto-generator particularly those intended for electromedical purposes.

Magneto Receiver. See BELL RECEIVER.

Magneto Ringer. A magneto generator for ringing telephone bells; sometimes also applied to the bell itself.

Magneto Ringing. The ringing of telephone bells by current from a magneto generator. Cf. BATTERY RINGING.

Magneto Speed Indicator. A speed indicator consisting of a small magneto generator connected to a voltmeter graduated to read directly in revs. per minute.

Magneto Telephone System. A telephone exchange in which the call signals are actuated by magneto generators at the subscribers' stations.

Magneto Voltage Regulator. A name sometimes used for the type of a.c. voltage regulator in which the ratio of a transformer is varied by movement of the core relatively to the windings.

Magneto-Cohesion. The cohesion between two magnetised surfaces in close contact, which is found to produce a resistance to tangential forces much greater than that calculated from the force of attraction and the coefficient of friction. See ROTARY DRUM RELAY.

Magneto-Electric Generator. See MAGNETO GENERATOR.

Magneto-Electric Machine. A generator or motor with permanent magnets as field magnets.

Magnetogram. A record made by a *Magnetograph*.

Magnetograph. A recording form of *Magnetometer* for registering changes in the earth's magnetic field.

Magnetometer. An apparatus for ascertaining the direction or the magnitude of magnetic force, such as that due to the earth or to neighbouring magnets, by the deflection of a magnetic needle or otherwise.

Magnetometer: Kew Pattern, Mirror, and Self-Registering. See KEW PATTERN MAGNETOMETER, etc.

Magnetometer Method. A method of testing the magnetic quality of iron or steel, depending upon the deflection of a *Magnetometer* by the poles of a long bar or wire of the substance to be tested magnetised by a known current in a long solenoid.

Magnetometry. The whole subject of magnetic measurement by means of the magnetometer.

Magnetomotive Force. A term analogous to *Electromotive Force*, applied to the magnetic circuit and signifying that which tends to produce magnetic flux, and equal to the line integral of the magnetic force along the path in question. The resulting flux is proportional to the m.m.f. divided by the *Reluctance* of the circuit. The m.m.f.'s and reluctances of different portions of the circuit can be considered separately. M.m.f. may also be defined as the line integral of magnetic force. The unit on the C.G.S. electromagnetic system is called the *Gilbert*, but m.m.f. is often measured in practice by the *Ampere-Turns* producing it. One ampere-turn is equivalent to 0.4π gilbert. Symbol: F .

Magneton. A name given to a theoretical ultimate unit of magnetic moment of which the magnetic moments of all ferromagnetic atoms appear to be integral multiples.

Magneto-Ohmmeter. An ohmmeter employing a magneto-generator as the source of voltage.

Magneto-Optical Rotations. The rotation of the plane of polarisation of plane polarised light, passing through such materials as Faraday's *Heavy Glass* in a magnetic field, or reflected from the surface or transmitted through a thin sheet of iron forming the pole of a magnet. See FARADAY, KERR and KUNDT EFFECTS.

Magneto-Optics. The science of the relations between magnetism and light.

Magnetophone. (1) See ROUND-SYKES MAGNETOPHONE. (2) An instrument similar in construction to a telephone receiver for producing a loud sound when supplied with an undulatory current. (3) A sound-recording instrument similar in purpose to the "Dictaphone," but employing the principle of the *Blattnerphone* or *Telegraphone*.

Magnetophone, Round-Sykes. See ROUND SYKES MAGNETOPHONE.

Magnetoscope. An instrument for detecting but not measuring a magnetic field. Cf. GALVANO-SCOPE.

Magnetostriction. The small change in dimensions produced in a mass of iron, etc., by magnetisation.

Magnetostriction Oscillator. An apparatus for controlling the frequency of oscillations depending upon the interaction of the mechanical motion of a rod due to magnetostriction and electrical oscillations in the magnetising circuit. Used in a similar manner to the *Quartz Resonator*.

Magnetron. A *Thermionic Valve* in which the stream of the electrons is controlled by a magnetic field. In large magnetrons producing continuous oscillations, the high frequency alternating field for the purpose is provided by the filament current and causes oscillations in the plate circuit of twice the frequency, without the use of a *Grid*. Such tubes can deal with powers up to about 1,000 kW.

Magnetron, Split Anode. See SPLIT ANODE MAGNETRON.

Magnetron Effect. The weakening of electron emission in a thermionic valve, due to the magnetic field of the filament current which imposes a limit on the output of large valves.

Magnetron Oscillations. Oscillations produced in *Thermionic Valves* circuits by the interaction of magnetic fields and electron streams.

Magnetron Rectifier. A gas tube rectifier in which the electrodes are not heated and the electron stream is controlled by a magnetic field.

Magnifier. A term used in cable telegraphy in preference to relay or amplifier, for an apparatus for amplifying signals received over a submarine cable by controlling a circuit otherwise than by opening and closing contacts (see below); also sometimes used for an *Amplifier* in wireless telephony.

Magnifier: Electrolytic, Heurtley, Hot-Wire, Selenium, and Thermionic. See *ELECTROLYTIC MAGNIFIER*, *HEURTLEY MAGNIFIER*, etc.

Main (electric). A conductor forming part of a scheme of electric supply and distribution and furnishing the supply to an installation or portion thereof.

Main(s): Distributing, Interconnecting, Negative, Neutral, Positive, Ring, Rising, Supply, Theatre, and Trunk. See *DISTRIBUTING MAIN*, *INTERCONNECTING MAIN*, etc.

Main and Tail Haulage. See *HAULAGE (ELECTRIC)*.

Main Circuit (of Meters, etc.). See *CURRENT CIRCUIT*.

Main Contact Spring (in Telephony). A contact spring making contact between two other contact springs.

Main Dispersion. See *PERIPHERAL DISPERSION*.

Main Distribution Frame. The frame in a telephone exchange to which the circuits from the cables entering the building are brought, usually carrying fuses, for every incoming circuit. Connections are taken thence to the intermediate distribution frames, and temporary connections can be made for testing.

Main Field. The field provided by

the main poles of a machine as distinguished from that provided for auxiliary purposes by commutating poles, compensating windings, etc., or that due to magnetic leakage.

Main Leakage. See *PERIPHERAL DISPERSION*.

Main Limit Switch. A *Limit Switch* which opens the main power circuit. Cf. *CONTROL LIMIT SWITCH*.

Main Poles. The poles of a machine which provide the main field as distinct from *Commutating Poles*.

Main Switchboard. The principal switchboard which controls the whole output of a generating station or the whole of the energy passing into an installation.

Mains (Electric). See *MAIN*.

Mains Receiver (Wireless). See *ALL MAINS RECEIVER*.

Mains Unit or Mains Power Unit (Wireless). See *BATTERY ELIMINATOR*.

Majorana Liquid Microphone. A microphone in which the diaphragm is attached to a nozzle and causes vibrations in a jet of liquid, and consequent alteration of the thickness of a film of liquid on the surface upon which the jet is falling. The resulting variation of resistance between electrodes in this surface produces the required fluctuations of the current.

Make-and-Break Contacts. Contacts such as those of the trembler of a bell, induction coil, etc., employed for the repeated completion and interruption of a circuit.

Make-before-Break Contact Spring (in Telephony). A contact spring arranged not to break its normal (back) contact before contact is established with the operating (front) contact.

Make Impulse. An *Impulse* consisting of a brief flow of current. Cf. *BREAK IMPULSE*.

Make Spark. A spark which jumps across contacts between which an c.m.f. exists, when they have approached very near to each other just before the completion of a circuit. Cf. *BREAK SPARK*.

Making Capacity. The maximum *making current* which a circuit-breaker, etc., is capable of dealing with under specified conditions.

Making Current. An expression used in connection with circuit-breakers for the peak current at the moment of closure.

Mance's Method. A *Wheatstone's Bridge* method of measuring the internal resistance of a battery in which the battery is placed in one arm of the bridge with a key in place of the usual battery, and a balance is obtained so that closing this key makes no alteration in the deflection of the galvanometer.

Manganin. An alloy of copper, manganese and nickel used for standard and other resistances, on account of its constancy of properties and low temperature coefficient.

Manbridge Condenser. A condenser made up of layers of paper which has been given a coating of tinfoil, by a special process, on one side, the whole being afterwards impregnated with paraffin wax. Used extensively in telegraph and telephone work, and for improvement of power factor.

Manual Ringing. Ringing of telephone bells controlled by hand-operated keys.

Manual Telephone System. A telephone system in which the calls are given verbally, and all switching operations are carried out by hand.

Map, Magnetic. See MAGNETIC MAP.

Marconi Directive Aerial. A type of partially directive aerial consisting of an inverted L aerial with a long horizontal portion.

Marconi Disc Discharger. See DISC DISCHARGER.

Marconi Magnetic Detector. See MAGNETIC DETECTOR.

Marconi Multiple Tuner. See MULTIPLE TUNER.

Marconi-Reiss Microphone. A form of carbon microphone used for broadcasting, etc., in which the sound waves act directly upon the carbon granules without a diaphragm.

Marconi System. The systems of wireless telegraphy associated with the name of G. Marconi have undergone so much alteration and development that no one method

can be defined under this heading. Originally employing an earthed aerial containing the spark gap and coherer in its own circuit, the system was later improved by the addition of coupled tuned circuits and different methods of spark production and detection, leading up to the valve and other methods of transmission and reception, and the short wave (Bevan) system with highly-directive aeriols now employed for the longest systems.

Marine Galvanometer. A galvanometer for use on board ship for cable work, etc., with the moving system suspended by a tight strip above and below, or otherwise, so as not to be affected by the rolling of the ship.

Marine Propulsion. See PROPULSION OF SHIPS, etc. (Electrical).

Mariner's Compass. A magnetic compass of the type usually employed on ships, with the card attached to and moving with the needle as distinguished from the type with a needle moving over a card fixed to the case.

Marked Pole. The *North Seeking* pole of a permanent magnet is often engraved with a line and is sometimes spoken of as the "marked" pole. Cf. UNMARKED POLE.

Marking Current. A telegraph signal current in the direction which causes the Morse instrument to mark the paper. Cf. SPACING CURRENT.

Marking Wave. A term used for the wavelength used during the actual Morse signal in wireless telegraph systems where signalling is affected by a change in frequency of the continuous waves employed and not by their interruption. Cf. SPACING WAVE.

Marx Circuit. An impulse circuit forming a surge generator in which a number of condensers charged in parallel are caused to spark over simultaneously, bridging the gaps which, when broken down, place them in series so that the full voltage is attained. The high resistances by which they are connected in parallel for charging only cause slight loss of energy.

Marx Rectifier. An arc rectifier in which the arc is struck across the electrode and extinguished by an air-blast. Pitting of the electrodes is prevented by keeping the arc in rotation by a magnetic field.

Mass Core. A core for electromagnetic apparatus, particularly in telegraphy, composed of pulverised iron or other magnetic material with a binder of non-magnetic material.

Mass Number. The number of *Protons* in the nucleus of an atom of a particular element. Cf. *Atomic Number*.

Mass Resistivity. The resistance per unit length of unit mass of a substance at a given temperature. Often more convenient than *Volume Resistivity* in dealing with wire.

Mass Spectrograph. An apparatus for obtaining the *Mass Spectrum* of a substance.

Mass Spectrum. A spectrum obtained by deflecting a beam of *Positive Rays* emitted from a tube, containing a residual gas to be investigated, by electric or magnetic fields. The extent of the deflection depends upon the *m/s* (the ratio of the mass of the projected positively charged particles of which the rays are composed to the atomic charge). Thus, every element has its characteristic spectrum lines like those of the light spectrum. *Isotopes* were discovered by investigations into mass spectra, which are now applicable to ionised metallic atoms as well as to gases.

Mast. A support for overhead lines, aerials, etc.; usually limited to tubular or lattice steel structures of considerable height and narrow base requiring rigging. Cf. *Tower*.

Mast Switch. A line sectionalising or other switch mounted on a mast or pole supporting an overhead line, to be actuated by a long rod with a hook or ring.

Master Clock. The principal time-keeper, in a system of electrical time-service, which is connected electrically to all the other clock dials of the system so that they are kept in synchronism with it.

Master Controller. A controller, such as that on an electric train

fitted with multiple unit control which controls one or more motors through *Contactors*.

Master Drive. See *INDEPENDENT Drive*.

Master Frequency Meter. See *INTERGRATING FREQUENCY METER*.

Master Switch. (1) A switch of small capacity controlling another circuit of which it does not form a part by means of relays, contactors, etc. (2) A switch in series with a number of others controlling separate lamps or circuits so that the whole may be turned off at once. (3) In automatic telephony: a switch controlling a group of proselectors automatically or otherwise.

Matrix (in Electrotyping). The mould upon which the copper is deposited to make an *Electrotype*.

Matthiessen's Standard. A standard of conductivity for copper wire according to which a wire one metre long weighing 1 gramme should have a resistance at 60°F. of 0.1539 ohm if hard drawn, and 0.1608 ohm if annealed. The conductivity of a sample of copper is expressed as a percentage of this standard.

Maturing (of Permanent Magnets). See *AGEING*.

Maxigraph. A supply meter attachment for recording on a chart the maximum demand over successive period. (See also *PRINTOMETER*.)

Maximum Circuit-Breaker. A circuit-breaker arranged with trip gear so that it is automatically opened when the current exceeds a predetermined maximum value. Cf. *MINIMUM CIRCUIT-BREAKER*.

Maximum Current Circuit-Breaker. Relay, etc. See *MAXIMUM CIRCUIT-BREAKER*, etc.

Maximum Cut-Out. A maximum circuit-breaker of small size.

Maximum Demand Indicator. An instrument, actuated thermally or otherwise, for indicating the maximum current or kilowatts that have flowed in a circuit during a given period since it was last set. See also *MAXIGRAPH* and *PRINTOMETER*.

Maximum Relay. A relay which actuates the trip gear of a *Circuit-*

- Breaker**, when the main current exceeds a predetermined maximum.
- Maximum Values**. See **PEAK VALUES**.
- Maximum Voltage Circuit-Breaker, Relay, etc.** See **OVER VOLTAGE CIRCUIT-BREAKER, etc.**
- Maxwell**. The name now adopted for the C.G.S. Unit of *Magnetic Flux*, being such that its removal from a circuit causes one electromagnetic unit of electricity to flow in the circuit. (Named after J. Clerk Maxwell, 1831-1879.)
- Maxwell Tubes**. Unit "Tubes" of magnetic or electric induction, emanating from magnetic poles or electric charges, of such magnitude that unit pole sends out 4π unit tubes of force. Cf. **FARADAY TUBES**.
- Maxwell's Rule**. Every portion of a circuit is acted upon by a force urging it in such a direction as to make it enclose the greatest possible number of lines of force.
- McColl Protective System**. See **BIASSÉD DIFFERENTIAL PROTECTIVE SYSTEM**.
- Mean Conical Candle-Power**. See **MEAN ZONAL CANDLE-POWER**.
- Mean Hemispherical Candle-Power**. The mean of the candle-power from a light source in all directions above, or all directions below, the horizontal plane. Also called *Mean Upper or Lower Hemispherical Intensity*; used particularly of lamps of uneven light distribution.
- Mean Horizontal Candle-Power or Mean Horizontal (Luminous) Intensity**. The mean of the candle-power from a light source in all directions in a horizontal plane; used particularly of certain classes of incandescent lamps and often measured by observations during rotation of the lamp on a vertical axis.
- Mean Lower Hemispherical (Luminous) Intensity**. See **MEAN HEMISPHERICAL CANDLE-POWER**.
- Mean Power**. See **MEAN VALUES**.
- Mean Spherical Candle-Power or Mean Spherical (Luminous) Intensity**. The mean of the candle-power from a light source in all directions, equal to *Luminous Flux* (Luminous) divided by 4π ; used particularly of lamps of irregular light distribution.
- Mean Upper Hemispherical (Luminous) Intensity**. See **MEAN HEMISPHERICAL CANDLE-POWER**.
- Mean Values** (of Voltage, Current, etc.). The average or arithmetic mean values of these quantities, when alternating or otherwise fluctuating; in the case of pure sine waves, $2/\pi$ (0.637) of the maximum value. Cf. **VIRTUAL or ROOT-MEAN-SQUARE VALUES**.
- Mean Zonal Candle-Power**. The mean of the candle-power from a light source in all directions making a given angle with the horizontal plane. (Also called *Mean Conical Candle-Power*.)
- Measurements, Absolute**. See **ABSOLUTE MEASUREMENTS**.
- Measuring Instruments** (Electrical). Instruments for indicating, recording, or integrating electrical quantities, such as galvanometers, ammeters, voltmeters, wattmeters, etc., or for measuring non-electrical quantities by electrical methods (e.g. *Electrical Pyrometers*.)
- Mecroscope**. An industrial form of *Noise-Measuring Set*.
- Mechanical Connector**. Apparatus for making *Mechanical Joints* in conductors.
- Mechanical Depolarisation**. Dissipation of hydrogen bubbles or other products causing *Polarisation* in a primary cell by mechanical means.
- Mechanical Drive** (in Wireless Transmission). *Independent Drive* controlled by tuning-fork or other mechanical oscillator.
- Mechanical Joint**. A conductive joint between cables or other conductors in which the metallic surfaces are clamped together mechanically without the use of solder; often used in the case of aluminium conductors.
- Mechanical Master Oscillator**. See **MECHANICAL DRIVE**.
- Mechanical Rectifiers**. Rectifiers such as those of the commutator and brush type in which the rectification is effected entirely by changes of contacts and not by physical or chemical conditions of unidirectional conductivity.
- Medical Coil**. An *Induction Coil* for administering electrical curative treatment.
- Medical Electrology**. The application

of electrical methods to medical practice.

Medical Electrolysis. See GALVANISM (2).

Medical Ionisation. The introduction of salts into tissues by passing a current through them causing electric *Osmosis*. (Also called *Ionic Medication*.)

Medium Edison Screw Cap. See EDISON SCREW CAP.

Medium Pressure or Voltage. The official Board of Trade description of a voltage above 250 volts but not exceeding 650 volts between any two conductors or between any conductor and earth. Cf. LOW, HIGH and EXTRA HIGH PRESSURE.

Medium Waves. Expression formerly in common use for wavelengths between 100 and 1,000 metres, but lately defined by the International Radio-Technical Committee as applying to waves between 200 and 3,000 metres (1,500–100 kc.). Cf. LONG, INTERMEDIATE, SHORT, and VERY SHORT WAVES.

Mega or Meg. Prefix meaning one million times. (Abbreviation: *M*.) See below.

Megacycle. One million cycles. Radio frequencies are sometimes expressed in megacycles per second. Cf. KILOCYCLES.

Megakelvin. One million "Kelvins" or *Kilowatt-hours*, a unit sometimes employed in stating the annual output of a generating station.

Megaline. A unit of magnetic flux equal to one million C.G.S. units, sometimes used in dynamo design, etc.

Megger. An instrument of the *Ohmmeter* type for measurement of insulation resistance by direct reading; distinguished by its compact form and employing a hand-driven generator in the same case, and using the same field magnets, as the moving coil indicating instrument. See also BRIDGE-MEGGER and DUOTER.

Megohm. One million ohms. The unit usually employed for insulation resistance and for high resistance for grid leaks, etc. Symbol: *MΩ*.

Meldinger's Cell. A form of *Gravity* pattern *Daniell* cell with an

electrolyte of zinc or magnesium sulphate.

Mercadier-Magunna Multiplex (Telegraph) System. A *Multiplex* system in which each message is sent on a different audio-frequency, and is selected at the receiving station by a *Monotelephone* which responds only to that frequency.

Mercury Air Valve Regulator. An appliance to regulate the vacuum in an "X" *Ray Tube* consisting of a branch tube connected to the main tube by aporous plug normally sealed by mercury which can be displaced by application of external air pressure, to allow a little air to enter the main tube. Cf. PILON and OSMO REGULATORS.

Mercury Arc Lamp. See MERCURY DISCHARGE LAMP.

Mercury Arc Rectifier. See MERCURY VAPOUR RECTIFIER.

Mercury Break or Interrupter. A contact-breaker for induction coils in which contact is made between moving metallic contacts and a jet of mercury provided by a small centrifugal pump driven by the same motor as the contacts.

Mercury Discharge Lamp. A lamp in which the light is derived from an incandescent column of mercury vapour in an exhausted tube of glass or quartz containing a small quantity of mercury with suitable electrodes. They are supplied by continuous current at ordinary voltages and the discharge through the mercury vapour has to be started by tilting the tube so that the mercury runs along it to "strike" the arc. Owing to the light being rich in ultra-violet rays these lamps are used extensively for photographic purposes, as well as to a limited extent for general illumination.

Mercury Electrode. A mercury surface in contact with samples of sheet materials for making the intimate contact required for capacitance tests, etc.

Mercury Electrolytic Meter. An *Electrolytic Meter* in which a mercury compound forms the electrolyte.

Mercury Helix Permeameter. A magnetic testing apparatus in which the flux is measured by the

mechanical pressure on a helix of mercury in an air-gap in the magnetic circuit.

Mercury Meter. See **MERCURY ELECTROSTATIC METER** and **MERCURY MOTOR METER**.

Mercury Motor Meter. A form of supply meter for direct current, in which the moving armature consists of a disc or helix of copper dipping into a bath of mercury from which the current is conveyed to it; usually of the ampere-hour type with permanent field magnets, e.g. *Chamberlain & Hookham* and *Ferranti Meters*.

Mercury Switch. A switch either with fixed contacts formed by mercury cups, or in which mercury in a closed tube is made to bridge over contacts by tilting the tube.

Mercury Unit. See **BRIDGE UNIT**.

Mercury Vapour Frequency Changer.

An apparatus similar to a *Mercury Vapour Rectifier* of the reversible type with the control grid excited at a different frequency from that of the supply suitable as a reversible link between systems of different frequencies.

Mercury Vapour Lamp. See **MERCURY DISCHARGE LAMP**.

Mercury Vapour Lamp, High Pressure. See **HIGH PRESSURE MERCURY VAPOUR LAMP**.

Mercury Vapour Rectifier. A rectifier depending for its action upon the unidirectional conductivity of the mercury arc in an exhausted vessel. Used in small sizes for accumulator charging from alternating current currents, and in larger sizes for running current and other direct current arc lamps from alternating current and for electric traction instead of rotary converter in substitution or on the train itself. In electric bulbs up to 200 L.W., and of the non-laid type up to about 5000 L.W. units. See also **PHOSPHOR**, **GRID CONTROL**, **THYATRON**, and **MILVACON**.

Meridian, Magnetic. See **MAGNETIC MERIDIAN**.

Merit, Figure of and Factor of. See **FIGURE OF MERIT** and **FACTOR OF MERIT**.

Merz-Hunter Protective System. See

SPLIT CONDUCTOR PROTECTIVE SYSTEM.

Merz-Price Protective System. A protective system for feeders and other circuits in which the circuit-breakers are opened by relays when there is lack of equality between the current flowing in at one end and out at the other due to leakage. The relays are included in a pilot wire circuit connected to current transformers at the two ends of the line in opposition.

Mesh Connection. The connection of phases in a polyphase circuit so that they form a closed figure with no neutral point; also called in the case of a three-phase system *Delta Connection*. Cf. **STAR CONNECTION**.

Mesh Voltage. The line voltage of a three-phase or six-phase system, i.e. in the latter case, that between consecutive lines. (Also called the *Hexagon Voltage*.) Cf. **DELTA VOLTAGE**, **DIAMETRICAL VOLTAGE**, and **STAR VOLTAGE**.

Mesny Circuit. A system of transmission of very short waves in which a symmetrical arrangement of two oscillating valves is employed with their plates and grids respectively coupled by inductances to the central points of which the p.t.t. connections are made.

Mesophotometer. An integrating photometer giving by one observation the average candle power in one plane from a source of light.

Messenger Wire. A name sometimes used for a *Suspension or Catenary Wire*.

Metabolons. The products of successive disintegration of radioactive bodies.

Metadyne. A direct current machine with more than two brushes per pole pair, used in various forms for transformation and regulation, particularly in converting from constant voltage to constant power.

Metal, Non-Arcing. See **NON-ARCING METAL**.

Metal Electrode (in Arc Welding). A rod of metal between which and the work the arc is struck and usually also serving to provide the filling material. See **BARE**.

COVERED, CORED and SHEATHED ELECTRODES.

Metal Filament Lamp. An incandescent lamp with a *Metal Filament*, usually of wire-drawn tungsten, either in a highly exhausted bulb or in a bulb containing an inert gas. See GAS FILLED LAMP.

Metal Filaments. *Filaments* for incandescent lamps made of metals of high fusing point, such as tungsten, made either by a squirting process from powdered tungsten with a suitable binder and afterwards rendered more homogeneous by heat treatment; or, as is now more usual, by true wire drawing through a die.

Metal Lamp. See METAL FILAMENT LAMP.

Metal Rectifier or Metal Oxide Rectifier. A form of rectifier depending on the unidirectional conductivity of a junction of such materials as copper and copper oxide not apparently involving any chemical or electrolytic action. (Also called *Electronic*, *Cuprox*, or *Barrier Film Rectifier*.)

Metal "V" Ring. The metal end ring of V-section which clamps the commutator bars in place.

Metal Valve. A *Thermionic Valve* in which a metal container replaces the glass bulb, and in some cases constitutes the anode.

Metal "X" Ray Tube. An "X" Ray Tube partly of glass and partly of metal, the latter for the prevention of egress of rays where not required.

Metal-Clad Switchgear. Switchgear in which all the conductors and insulators are within earthen metal covers, including that in which portions are covered separately.

Metal-Cored Carbons. Are lamp carbons with metal cores for the purpose of improving their conductivity.

Metal-Enclosed Switchgear. Switchgear, the whole assembly of which is enclosed in an earthed metal casing.

Metallic Arc Welding. Welding with an arc between metal electrodes, e.g. between the work and a stick of the metal to be added to the joint, with or without a suitable flux.

Metallic Circuit. A two-wire telephone circuit insulated throughout as distinguished from a single wire circuit with earth return.

Metallic Filament. See METAL FILAMENT.

Metallic Filament Lamp. See METAL FILAMENT LAMP.

Metallised Filament. A lamp filament of carbon which has received heat treatment making it almost metallic in properties, by partially converting it into graphite. Such a filament can be run at a lower specific consumption, i.e. a higher "Efficiency," than an ordinary carbon filament, but not so low as a metal filament. (Also called *Graphitised Filament*.)

Metallised Valve. A *Thermionic Valve*, the bulb of which is sprayed with a metal film to produce a screening effect to counteract the effect of stray capacity couplings.

Metallising. The covering of the surface of a non-conducting mould or other article with a metallic or other conducting layer so that electro-deposition may be effected thereon.

Meter. A term sometimes used to cover all classes of switchboard and other electrical measuring instruments, but often limited to integrating meters (*Watt-hour meters* and *Ampere-hour meters*, etc.), for electric supply, and for counting telephone calls, etc.

Meter: Alternating Current, Ampere-hour, Arno, Aron, Bastian, Battery, Call, Clock, Continuous Current, Continuously Integrating, Coulomb, Current Square, Decibel, Discontinuously Integrating, Dose, Double Tariff, Effective Call, Electricity, Energy, Frequency, Form-Factor, Gas, Heat Direct Current, Horsepower, Hour, House Service, Induction, Ineffective Call, Integrating, Kilowatt-Hour, kVAh., Lightning Severity, Mercury, Mercury Electrolytic, Mercury Motor, Milliampere-Second, Motor, Oscillating, Overcompensated, Peak, Phonic Capacitance, Polyphase, Power, Power-Factor, Prepayment, Prescott, Reactive, Ampere-Hour, Reactive Power, Shunted, Single-Phase, Sine, Slot, Supply,

Switchboard, Telephone, Thomson, Three-Phase, Three-Wire, Time, Torque, Tramcar, Two-Rate, Ultra-Violet Light, Undercompensated, Volt-Ampere-Hour, Watt-Hour, Wattless Component, and Wave. See ALTERNATING CURRENT METER, AMPERE-HOUR METER, etc. (See also references under INSTRUMENTS.)

Meter Dial. The indicating portion of a meter where indexes move over graduated circles corresponding respectively to the units, tens, hundreds, thousands, etc., of units consumed. Cf. CYCLOMETER DIALS.

Meter Key. A key on a telephone switchboard which closes a circuit to actuate a *Telephone Meter*.

Meter Lamp. A signal lamp on a telephone switchboard which lights up to indicate that a call meter has been actuated.

Meter Loss. The energy loss produced by resistance, eddy currents, hysteresis, friction, etc., in a meter.

Meter Panel. A *Panel* on a switchboard for the accommodation of watt-hour meters, etc.

Meter Rack. A frame in a telephone exchange on which are mounted rows of call meters.

Metre-Ampere. An expression used in connection with wireless aerials for the product of the mean height and the rated current.

Metre Bridge. A *Wheatstone's Bridge* of the *Slide Wire* pattern with the wire one metre in length.

Metre Candle. See LUX.

Mho. The unit of *Conductance* or *Admittance*, being that of a conductor having a resistance or impedance of one ohm.

Mica. A mineral, occurring in various parts of the world in irregular blocks, which can be split into thin uniform sheets, consisting of silicates of aluminium and potassium, sodium, etc.; employed to a large extent for insulating purposes, especially for commutators, on account of its high dielectric strength and power of resisting high temperatures.

Mica "V" Ring. A conical shaped ring of mica, micranite, etc., which insulates the commutator bars from the *Metal "V" ring*.

Micanite. Sheets, plates, tubes, etc., made up of mica laminations consolidated by special varnishes under pressure. By this means mica can be made up into shapes and sizes not possible with sheet mica; Used particularly for commutator rings and slot linings. (Also called RECONSTRUCTED MICA.) See also MICALEX.

Micarta. An insulating material capable of replacing ebonite, etc., made chiefly of mica.

Michelson-Morley Experiment. An experiment made in 1887 to endeavour to ascertain whether there is relative movement between the *Ether* and the earth, by observations of interference effects between beams of light travelling with and across the earth's motion. The result appeared to indicate that the earth carries the ether round with it, as no difference in the velocity of light in the two cases could be detected; in contradiction to other experiments and theories; but can be explained by the assumption that the dimensions of the apparatus change slightly due to their motion, as indicated by Einstein's theory of relativity. After doubts had been expressed as to its validity, the experiment was confirmed in 1928 by repetition on a much increased scale.

Micro- Prefix meaning one millionth, e.g. microampere, one millionth of an ampere; a unit sometimes used for very small currents. (Symbol: μ .)

Micro-Drive (in Lift Control). An arrangement in which an auxiliary motor is employed to adjust the floor levelling after stopping in the ordinary way by rotating the brake shoes on the drum driven by the main motor.

Microfarad. (Abbreviation: μF .) The most widely used practical unit of capacitance; being one millionth of a *Farad*. The latter although used in many formulae on account of its correspondence with the other *Practical Units*, is inconveniently large for use in defining the capacitances met with in practice.

Microgalvanometer. A sensitive

galvanometer in which a very small deflection is optically magnified.

Microgap Switch. A switch for low voltage a.c. in which the separation of the contacts is about 0.005 in. The current is interrupted by neutral repulsion of electrons from the contacts.

Microge. See TERRELLA.

Micro-Henry. Abbreviation: μH . One millionth of a henry.

Microhm. Abbreviation: $\mu\Omega$. One millionth of an Ohm.

Microhm-Centimetre. A name sometimes used for a unit of *Volume Resistivity*. See MICROHM.

Micrometer (Electric). An instrument for measuring small movements, depending on flux changes caused by minute alterations in an air gap in a magnetic circuit. Used in conjunction with an oscillograph for recording vibrations and rapid changes of pressure on a diaphragm. Cf. ULTRAMICROMETER.

Micrometer, Spark. See SPARK MICROMETER.

Micrometer Gap. See SPARK MICROMETER.

Microphone. An instrument founded on the discoveries of Hughes (1878) and Edison (1877), devised for magnifying small sounds, and now used in a slightly different form as a telephone transmitter. The ordinary form consists essentially of a diaphragm set in vibration by the sound waves and causing by its motion variation in the resistance of a mass of loosely packed carbon granules and corresponding undulations in the current through the instrument faithfully copying the form of the original sound waves. See also TELEPHONE RECEIVER. A number of other forms (see below) are used to a limited extent for wireless telephony and for experimental purposes, and the term has come to be applied to any variety of sensitive telephone transmitter, whether dependant upon variation of resistance or not.

Microphone: Carbon, Condenser, Diaphragmless, Differential, Electrocapillary, Electromagnetic, Flame, Glow-Discharge, Majorana,

Marconi-Reiss, Moving Coil, Multiple, Push-Pull, Ribbon, and Solid Back. See CARBON MICROPHONE, CONDENSER MICROPHONE, etc.

Microphone Amplifier. (1) An amplifier used in conjunction with a broadcasting microphone to amplify the variations of current caused thereby before their transmission to the *Control* or *Modulating System*. (2) A microphone acting on the same principles as a *Microphone Relay*.

Microphone Battery. The battery which supplies the current in a microphone circuit.

Microphone Circuit. The local circuit containing a microphone, a battery, and the primary of an *Induction Coil*.

Microphone Relay. A relay in which the slight movement of the armature of an electromagnet varies the resistance of a loose carbon contact and thereby controls the variations of current in the local circuit with a similar action to that of a *Microphone*.

Microphone Transmitter. See MICROPHONE.

Microphonic Flame. See FLAME MICROPHONE.

Microphonic Noise. *l'alve Noise* in a wireless receiving apparatus, consisting of a more or less musical note, due to the effect of mechanical vibration of the filament.

Microphonic Valve. A valve with insufficiently rigid electrodes liable to take up vibrations which produce *Microphonic Noise*.

Microphotometer. A photometer of a high degree of accuracy. In one form the changes of current produced by change of illumination falling on a *Photoelectric Cell* are amplified by *Thermionic Valves*.

Micro-Rays. A name sometimes used for electric waves from one to ten metres wavelength used in recent systems of wireless communication over short distances.

Microscope, Electron and Infra-Red. See ELECTRON MICROSCOPE and INFRA-RED MICROSCOPE.

Microtelephone. A name sometimes given to a hand combination telephone set in which the trans-

mitter (*Microphone*) and *Receiver* are joined together and held in the hand when in use.

Micro-Waves. See *MICRO RAY*.

Middle Wire. The conductor in a *Three Wire System* which is intermediate in position between the two main or *Outer Conductors*; sometimes called the *Neutral Wire*, and in some systems connected to earth.

Mid-Point Protective System. A system for protecting generators against faults between turns, in which tappings are taken from the middle of each phase winding, and connected to tripping transformers where the voltage in the halves of the windings are balanced on the *Core Balance* system.

Magnet Furnace. A form of electric arc furnace with a continuous vertical electrode built up as required by sector shaped carbon blocks in a metal case and controlled with a special plate.

Migration Constant. The ratio of the velocity of a positive or negative ion of a substance during electrolysis to the sum of the velocities of the positive and negative ions. (Also called *Transport Number*.)

Migration of Ions. The passage of positively charged ions (*Cations*) towards the cathode and of negatively charged ions (*Anions*) toward the anode during electrolysis. See *MOLTALY*.

Mil. One thousandth of an inch.

Mil, Circular. See *CIRCULAR MIL*.

Mil-ammeter. See *MILLIAMPERE-METER*.

Milker. See *MILKING GENERATOR*.

Milking. The operation of fully charging individual cells of an accumulator battery; so called on account of the milky appearance of the electrolyte when the cell is fully charged, due to the presence of small bubbles of gas.

Milking Booster. See *MILKING GENERATOR*.

Milking Generator. A small motor generator giving the voltage required for charging single cells of an accumulator battery. (Sometimes incorrectly called *MILKING BOOSTER*.)

Mill Fitting. See *FACTORY FITTING*.

Milled Slots. Slots in armatures or rotors of small machines made by milling them out of the complete cylindrical assembled core instead of using ready slotted discs to build it up.

Miller Effect. The increase in effective capacitance between the grid and the filament due to interaction of the capacitance between the plate and the grid which causes a charge to be induced electrostatically by the plate on the grid.

Miller Bridge. A potentiometer arrangement connected between the grid and plate currents of a thermionic valve with the variable point connected to the cathode and adjusted till there is balance in the plate circuit telephone, when the valve is fed with a radio-frequency voltage. The ratio of the arms of the potentiometer is then the amplifying factor. The apparatus can also be used for determining the internal resistance of the valve.

Milli-. Prefix meaning one thousandth, e.g. millivolt, one thousandth of a volt. (Abbreviation: *m.*)

Milliammeter. See *MILLIAMPERE-METER*.

Milliamperere. One thousandth of an ampere. A unit used by telegraph and telephone engineers, who are therefore sometimes spoken of as "milliamperemen."

Milliamperemeter. An ammeter graduated so that each division indicates one milliamperere; often arranged with suitable resistances so that the same instrument can be used also as a millivoltmeter.

Milliamperere-second Meter. An apparatus taking into account the current through a "X" *Ray Tube* as well as time, for obtaining effects of variation in the output of the tube in controlling exposure in *Radiography*.

Milli-Lambert. See *LAMBERT*.

Milli-micro-. Prefix meaning one thousandth and millionth. Abbreviation: *mp.* Cf. *BRIE*.

Millivoltmeter. A voltmeter graduated so that each division indicates

one millivolt; often arranged with suitable resistances so that the same instrument can be used also as a milliamperemeter.

Mine Exploder. A magneto-generator specially constructed for providing the current to detonate explosive charges. Sometimes arranged to be operated by pushing down a rack or twisting a handle, and with a device which only connects the armature to the circuit when full speed has been attained. (Also called *Shot-Firing Generator* and *Blasting Machine*.)

Mineralised Carbons. Carbons impregnated with metallic salts for use in *Flame Arc Lamps*.

Miner's Dip Needle. A portable form of *Dipping Needle* for revealing by its change of inclination the presence of magnetic ore.

Miner's Lamp (Electric). A self-contained lamp complete with accumulator and switch, of substantial flame proof construction and efficiently locked, for use in mines where explosive gases are likely to be present, to take the place of the Davy (oil) safety lamp.

Miniature Edison Screw Cap. A lamp cap similar to that described under *Edison Screw Cap*, but of much smaller size (about $\frac{3}{8}$ in. diam.); used for flash lamps, etc. Also called *Flash Light Edison Screw Cap*.

Minimum Circuit-Breaker. See MINIMUM CURRENT AND MINIMUM VOLTAGE CIRCUIT-BREAKERS.

Minimum Cut-Out. A *Minimum Circuit-Breaker* of small size.

Minimum Relay. A relay arranged to operate a tripping circuit when the main current falls below a predetermined minimum value.

Mining Equipment (Electric). See AIR COMPRESSOR, COAL CUTTER, CONVEYER, FLAME PROOF APPARATUS, HAULAGE, MINER'S LAMP, PUMPING PLANT, ROCK DRILLS, VENTILATING PLANT, and WINDER, etc.

Mining Locomotive. An electric locomotive taking current either from a trolley wire or equipped with accumulators, of specially compact design for use in mines.

Mirror Galvanometer, Magnetometer, etc. See REFLECTING, GALVANOMETER, etc.

Mistuning. See DETUNING.

Mixed Retroaction. *Retroaction* in a wireless receiving apparatus in which both electrostatic and electromagnetic coupling are employed.

Mixing Key. A key used in certain methods of capacitance testing to connect the capacitance to be measured to a standard condenser, after both have been charged, to allow their charges to mix, so that, if they exactly balance, they will neutralize each other.

Mixing Unit. A potentiometer arrangement whereby the output of two broadcasting microphones can be combined in varying proportions in the amplifier circuit, e.g. when a background of music or other sounds is to support a dramatic performance in another studio.

M.K.S. Units. The practical system of electrical units (amperes, volts, etc.) which may be taken as being founded on the metre, kilogram, and second if the permeability of space is taken as 10^{-9} instead of 1 in the same way as the C.G.S. system is based on the centimetre gramme and second. Adopted in 1935 by the International Electrotechnical Commission as superseding the C.G.S. absolute electromagnetic and electrostatic systems.

Mobility. The velocity of an ion of a particular material in electrolysis under a potential gradient of one volt per centimetre. See IONIC VELOCITY AND MIGRATION OF IONS.

Model, Magnetic. See MAGNETIC MODEL.

Modulated High Frequency, Amplification of. See AMPLIFICATION OF MODULATED HIGH FREQUENCY.

Modulated Keyed Continuous Waves. *Continuous Waves*, modulated at an audio-frequency to give a clear unvarying note on reception, and broken up into signals by a key. (Sometimes called *Type A2 Waves*.) See TONIC TRAIN AND INTERRUPTED CONTINUOUS WAVES.

Modulating Grid (in a Cathode Ray Television Tube). The electrode

near the cathode which controls the intensity of the electron beam in accordance with the signals received.

Modulating Valve. A thermionic valve used in a wireless transmitter to amplify the audiofrequency oscillations produced by the microphone and to superpose them upon the carrier wave by suitable action upon the plate circuit of the oscillating valve or an amplifier connected thereto. (Also called *Control Valve*.) See also **CHOKE MODULATOR**.

Modulation. The periodic alteration of amplitude, frequency or phase of the *Carrier Wave* according to the sound waves by the action of the microphone, or in some other way, on some part of the transmitting circuit. Cf. **DEMODULATION**. See references under *Modulator*.

Modulation, Class B, Cross, Frequency, Linear, and Series. See **CLASS B, MODULATION, CROSS MODULATION**, etc.

Modulation Meter. An apparatus for measuring the depth of modulation of transmitted waves.

Modulation Percentage. The ratio of the peak values of the variation of amplitude due to modulation of a transmitted wave in wireless telephony to that of the unmodulated carrier wave, expressed as a percentage. Symbol: *K*.

Modulation System. See **CONTROL SYSTEM**.

Modulator. The apparatus which superposes the modulations on the carrier current or waves in a line or wireless telephone system. See also **MODULATING CHIM**.

Modulator: Absorption, Anode, Balanced, Chereix, Choke, Double, Grid, Heising, High Power Choke, Low Power Choke, Magnetic, and Plate. See **ABSORPTION MODULATOR, ANODE MODULATOR**, etc.

Moissan Furnace. An experimental *Arc Furnace* with horizontal carbon electrodes for very high temperatures. Designed by H. Moissan (1852-1907).

Molecular Conductivity. The electrolytic conductivity of a solution divided by its concentration; or

the number of gramme equivalents per c.c.

Molecular Theory of Magnetisation. A theory of magnetisation by assuming that each molecule is a separate magnet with freedom of angular movement. Cf. EWING'S THEORY OF MAGNETISATION.

MQ. Abbreviation for *Megohm*.

Moment, Magnetic. See **MAGNETIC MOMENT**.

Monitor, Automatic. See **AUTOMATIC MONITOR**.

Monochromatic Pyrometer. See **OPTICAL PYROMETER**.

Monocyclic Alternator. An Alternator with an auxiliary or *Teaser* winding connected to the middle point of the main single-phase winding, and producing a voltage in quadrature with the main voltage. See **MONOCYCLIC SYSTEM**.

Monocyclic System. A system of distribution, formerly used in America, in which the principal supply for lighting was taken from single phase mains, but a third wire taken from the auxiliary coil of a *Monocyclic Alternator* was also used to supply three-phase current through a suitably connected transformer to a limited number of induction motors on the system.

Monotelephone. A telephone receiver which has a selective action in responding to only one audio-frequency. See **MERCADIER MARGUNNA MULTIPLEX SYSTEM**.

Monophase. See **SINGLE-PHASE**.

Monorail Traction. A system of electric traction in which only one track rail is employed, either with an elevated rail below which the cars are suspended from trucks running on the rail or employing cars rendered stable by gyrostats.

Monotooth Alternator. An alternator with all the armature conductors under one pole arranged in a single coil lying in one pair of large slots.

Montegal. An aluminium alloy containing calcium, of high tensile strength, suitable for transmission lines.

Moore Lamp. A form of discharge lamp employing long tubes, containing gases other than rare

gases or mercury or sodium vapour, and provided with an automatic arrangement for regulating the vacuum.

Morse Apparatus. Any transmitting or receiving instrument for dealing with messages in the Morse Code.

Morse Inker. A telegraph receiving instrument which marks the message of a paper strip by means of an inky wheel attached to a lever worked by the armature of an electromagnet, in the Morse Code.

Morse Key. A single lever key for signalling in the Morse Code. See DOUBLE CURRENT KEY, SINGLE CURRENT KEY, MARKING CURRENT, SPACING CURRENT, etc.

Morse Multiplex (Telegraph) System. A *Multiplex System* for signalling in the Morse Code; called *Multiplex Diode*, *Triode*, *Tetrode*, *Pentode*, or *Hexode*, according as it provides for 1, 2, 3, 4, 5, or 6 ways.

Morse Sounder. A telegraph receiving instrument which gives a distinctly audible sound on the attraction and release of the armature, owing to its striking against stops, at the beginning and end of each Dot and Dash, from which sounds the message can be read by a trained operator.

Morse Telegraph System. Any telegraph system employing the Morse Code.

Moscicki Condenser. A condenser consisting of a form of *Leyden Jar* adapted to engineering purposes, composed of a glass tube specially thickened at the neck where the dielectric stress is greatest, provided with inner and outer metallic coatings and mounted in special porcelain insulators.

Moscicki Furnace. A form of *Arc Furnace* for *Fixation of Nitrogen* with concentric vertical electrodes round which the arc is made to rotate by a d.c. field.

Motograph. See ELECTROMOTOGRAPH.

Motograph Relay. An early *Relay* working on the same principle as the *Edison Loud Speaking Telephone*.

Motor (Electric). Any machine or apparatus for converting electrical

energy into mechanical work; usually consisting of a stationary portion (*Stator* or *Field Magnet* system), and a rotating portion (*Rotor* or *Armature*), both composed of some form of iron core carrying windings through which a current passes. Cf. GENERATOR. Extensively used to provide motive power for driving all classes of machinery, etc., when supplied with electric current.

Motor: Adjustable-Speed, All-Watt, Alternating-Current, Alternating-Current Commutator, Asynchronous, Auto-synchronous, Auxiliary Lift, Back-Geared, Bisynchronous, Boucherot, Box-Frame, Capacitor, Cascade, Change-Pole, Change-Speed, Commutator, Compensated, Compensated-Induction, Compensated-Repulsion, Compensated-Series, Compound-Wound, Concatenated, Constant-Current, Constant-Speed, Constant-Voltage, Continuous-Current, Crane, Déri, Differentially-Wound, Direct Current, Double-Commutator, Double Deck, Double Squirrel Cage, Doubly-Fed, Drip-Proof, Electro-, Electrostatic, Enclosed, Enclosed Self Cooled, Enclosed-Ventilated, Fan, Fan-Cooled, Ferraris, Flame-Proof, Frame-Cooled, Fully-Enclosed, Geared, Gearless, Immersible, Induction, Induction Discs, Induction Type Synchronous, Interpole, Inverse Speed, Inverted, Inverted-Repulsion, Latour-Winter-Eichberg, Lift, Multipolar, Multispeed, Narrow-Gauge, Neutralised Series, Non-Synchronous, Open, Over-excited-Synchronous, Phonic, Pilot, Pipe-Ventilated, Plate Protected, Polyphase, Polyphase-Commutator, Pony, Protected, Pump, Railway, Reciprocating, Repulsion, Reversible, Screen Protected, Self-Ventilated, Semi-enclosed, Separately Air-cooled, Separately Excited, Series, Series-Compensated, Series-Conduction, Series-Induction-Conduction, Shunt, Shunt-Conduction, Shunt-Induction, Signal, Single-Phase, Single-Phase Commutator, Single-Phase-Induction, Slip-Ring, Spinner, Splash-Proof, Squirrel-Cage, Squirrel-Cage Repulsion, Starting, Step by Step

Submersible, Synaut, Synchronised-Induction, Synchronous, Synchronous Induction, Synduct, Three-Phase, Torque, Totally-Enclosed, Traction, Tramway, Two-Phase, Variable-Speed, Varying-Speed, Ventilated, Vertical-Shaft, Vertical-Spindle, Water-Cooled, Water-tight, Weatherproof, and Winter-Eichberg. See ADJUSTABLE SPEED MOTOR, ALL-WATT MOTOR, etc.

Motor-Alternator. A motor-generator set consisting of an alternator driven by a direct current or alternating current motor; e.g. for converting from direct to alternating current or for frequency changing.

Motor-Blower. A centrifugal blower directly coupled to or built as an integral part of an electric motor.

Motor-Bogie. A bogie or truck on an electric locomotive, tramcar, or railway coach which carries one or more motors.

Motor-Booster. See BOOSTER.

Motor-Break. An interrupter of the mercury or other pattern driven by a motor. Cf. HAMMER BREAK.

Motor-Car. Any tramway or railway vehicle which carries its own propelling motor or motors. (Also used extensively for non-electrical road automobiles.) Cf. TRAILER.

Motor-Coach. A railway passenger coach which carries its own propelling motor or motors. Cf. TRAILER.

Motor-Converter. A converting set for converting from alternating to continuous current, used in railway and other substations occupying an intermediate position between a motor-generator and a rotary converter and combining some of the advantages of both. A rotary converter armature is coupled to the rotor of an induction motor, and suitable points in their windings are interconnected. The rotor runs at half the synchronous speed, and half the power between the two machines is transmitted electrically and half mechanically. Transformers are usually unnecessary on the h.t. side. (Known also as *Cascade Converter*, *Bragstad Converter*, and *La Cour Converter*.)

Motor-Driven Interrupter. See MOTOR-BREAK.

Motor-Dynamo. A motor-driven *Dynamo*, i.e. a *Motor-Generator* for an output of continuous current.

Motor-Generator. A set consisting of one or more generators direct coupled to, and driven by, one or more electric motors, e.g. for converting from a.c. to d.c. or *vice versa* from one voltage or frequency or phase to another, or to obtain a variable from a fixed voltage.

Motor-Generator Locomotive. A locomotive carrying a motor to convert single-phase current taken from the line to continuous current for the driving motors.

Motor-Generator Set. See MOTOR GENERATOR.

Motor-Meter. A supply meter, either of the watt-hour or ampere-hour type, in which the counting mechanism is actuated by a form of electric motor arranged, in combination with a brake of some kind, so that its speed is proportional to the current or energy flowing in the circuit. In one common form, used both for alternating and for continuous current, the field is provided by coils carrying the current, without an iron core, and the armature, complete with commutator, is connected across the voltage. In others, for alternating current only, a simple form of induction motor is used, while in some ampere-hour meters permanent field magnets are used. See MERCURY MOTOR METER, INDUCTION METER, EDDY CURRENT BRAKE, etc.

Motor-Operated Switch. A large switch, such as a main oil switch in which the actual closing of the contacts is performed by an electric motor controlled from a distance. See REMOTE CONTROL.

Motor-Pump. A compact self-contained set consisting of a pump and its driving motor.

Motor-Starter. An apparatus comprising the necessary switchgear, resistances, etc., for producing the required conditions for starting a motor and changing to running

conditions when the speed increases; such as gradually cutting out resistances in the case of direct current motors, or rotor resistance in the case of slipping induction motors, or making the necessary changes of connections for starting by the *Star-Delta* or *Autotransformer* methods, etc. The name starter is usually limited to apparatus not adapted for remaining in the positions giving intermediate speeds for any length of time. See also references under **STARTER**, **NO-VOLTAGE**, and **OVER-LOAD RELEASES**.

Motor-Starting Switch. A switch used for starting a motor which is switched straight on to the circuit without the introduction of resistance. Cf. **MOTOR STARTER**.

Motor-Transformer. A name sometimes used for a motor-generator for converting from one direct voltage to another.

Moulded Insulators. Insulators made in forms suitable for particular purposes, under pressure in a mould, of special mixtures of materials.

Moulding. *Wooden Casing* for interior wiring.

Moulin Voltmeter. See **THERMIONIC VOLTMETER**.

Mousemill. A name sometimes given to the simple form of influence machine combined with its electromagnetic driving motor which was used in the early forms of *Kelvin Siphon Recorder* to impart an electric charge to the ink enabling it to flow freely from the glass tube of capillary dimensions which formed the recording pen.

Moving-Coil Ammeter, Galvanometer, Voltmeter, Wattmeter, etc. See **MOVING-COIL INSTRUMENTS**.

Moving-Coil Instruments. Measuring instruments in which the moving system carrying the pointer or mirror consists essentially of a suspended or pivoted coil constrained by springs, or by the torsion of the suspension, and traversed by the current to be measured or by a known fraction thereof, swinging in a magnetic field including: Sometimes limited to those for direct current in which

the field is provided by permanent magnets, or including instruments of the *Dynamometer* type in which the field is provided by a coil without an iron core, and instruments in which the field is provided by an electromagnet, such as oscillographs and certain wattmeters.

Moving-Coil Loud Speaker. A type of loud speaker in which the moving system is a coil without iron caused to vibrate in a powerful constant magnetic field and attached to the cone or other form of diaphragm designed to give very pure reproduction. (Also called *Coil-Driven Loud Speaker* and *Dynamic Loud Speaker*.)

Moving-Coil Microphone. See **ROUND SYKES MAGNETOPHONE**.

Moving-Coil Transformer. A transformer in which one winding is movable relatively to the other for regulating purposes. Sometimes used in constant current systems.

Moving-Conductor Instruments. Instruments in which the indication is given by movement of a current-carrying conductor or its equivalent, including those usually called *Moving Coil Instruments* as well as *Cathode Ray Instruments*.

Moving-Dielectric Voltmeter. A high tension voltmeter depending upon the tendency of a "needle" of higher dielectric constant than the surrounding medium to set itself at right angles to an electrostatic field.

Moving-Iron Instruments. Measuring instruments in which the moving system consists essentially of a mass of magnetic material, which is deflected by the current to be measured, or a known fraction thereof, in a fixed coil or coils; suitable either for direct or alternating currents, where a very high degree of accuracy is not required, also called *Electromagnetic Instruments* and *Soft Iron Instruments*. Cf. **MOVING COIL**, **HOT WIRE**, **ELECTROSTATIC**, **INDUCTION**, and **DYNAMOMETER TYPE INSTRUMENTS**.

Moving-Magnet Galvanometer, Instruments, etc. The class of galvanometer, or other instruments, in

which the coils are fixed, and the moving system contains permanently magnetised "needles."

Mu (μ) (Greek letter "mu," equivalent to "m"). A symbol used (1) for *Permeability*, and for *Amplification Factor*, and (2) for the millionth part of a unit, e.g. μF . microfarad.

Müller Tube. A variety of hot cathode tube with an auxiliary cathode, or grid, connected to the main cathode through a leak resistance.

Multibreak Switch, etc. A switch, etc., opening the circuit at more than one point on each pole.

Multicellular Voltmeter. An *Electrostatic Voltmeter* in which a number of moving sectors mounted on one axis are drawn into a number of fixed coils arranged in a vertical row.

Multichannel Television. A system of *Television* in which the picture is built up of a very large number of separate elements divided into several sections, each worked independently on a different frequency band.

Multichannel Voice-Frequency Telegraph System. See VOICE-FREQUENCY TELEGRAPH SYSTEM.

Multicircuit Winding. See LAP WINDING.

Multicore Cable. Cable containing three or more separately insulated cores not arranged concentrically. See TWO-CORE CABLE, THREE-CORE CABLE, etc.

Multifilament Lamp. An *Incandescent Lamp* in which several separate filaments are mounted in one bulb, either in series for exceptionally high pressures or in parallel for exceptionally high candle-powers considering the pressure, or with independent connections for alternative or simultaneous use for varying the candle-power, or in the case of signal or navigation lamps to avoid extinction when one filament breaks.

Multifrequency Alternator or Generator. An alternator capable of generating current at more than one frequency alternatively, by variation of the number of

field poles or otherwise; used in some systems of electrical *Propulsion of Ships*.

Multigap Arrester. A lightning or surge arrester in which a number of spark gaps are used in series.

Multigap Discharger. A discharger for spark systems of wireless transmission in which a number of gaps are used in series.

Multigrad Valve. A *Thermionic Valve* with more than one grid, e.g. a *Pentode* or a *Screen Grid Valve*.

Multiphase. See POLYPHASE.

Multiple. In telephone exchange switchboards, the jacks connected to every subscriber's line which are provided on every section of the junction operators' boards (or in small exchanges the subscriber's operators' boards), so that any operator can make connection to any subscriber's line are spoken of as "multiples." In the same way, in automatic telephony, the groups of connections by which lines are brought to the *Banks* of a number of selectors. As a verb, to make a telephone circuit available at a number of points.

Multiple, Level and Section. See LEVEL MULTIPLE and SECTION MULTIPLE.

Multiple Arc. An old-fashioned expression for connection in parallel.

Multiple Circuit Winding. See LAP WINDING.

Multiple Coil. A coil arranged to occupy more than one pair of slots.

Multiple Contact Switch. A switch in which one moving contact moves over a number of alternative fixed contacts; as in a switch controlling a regulating resistance or making connection to one of a number of alternative circuits.

Multiple Duct. See CABLE DUCT.

Multiple Feeder. See PARALLEL FEEDER.

Multiple Jack. See MULTIPLE.

Multiple Microphone. A microphone with a number of carbon elements all acted upon by one diaphragm.

Multiple Reception. Wireless reception of several separate signals simultaneously on the same aerial or with the same carrier-frequency.

Multiple Series Connection. The connection of cells, lamps or other apparatus in several parallel branches each containing a number in series. Cf. SERIES MULTIPLE.

Multiple Switch Controller and Multiple Switch Starter. A *Controller* or *Motor Starter* in which each section of the starting resistance is short-circuited successively by a separate switch. The switches are usually of the *Knife* pattern, mounted side by side in a row.

Multiple Tuned Aerial. An aerial to which several separately tuned circuits are connected.

Multiple Tuner (Marconi). An early tuning apparatus for use with the Marconi magnetic detector.

Multiple Twin Cable. A telephone cable containing a number of cores each consisting of two twisted pairs twisted together. Cf. QUAD CABLE.

Multiple Unit Control. A system of electric train control in which each motor coach is provided with its own current collecting and *Contact* apparatus, but the control circuits are carried along the train so that the motors of all the motor coaches can be controlled by any one master controller on the train.

Multiple Unit Controller. A *Master Controller* used in *Multiple Unit Control*.

Multiple Valve. A *Thermionic Valve* with several sets of electrodes in one bulb acting as independent valves.

Multiple Voltage System. A system of electric supply in which more than two mains are provided, so that a supply at two or more alternative voltages can be taken according to the purpose for which it is required; e.g. a *Three-Wire System* where lighting and small motors are supplied on one or other side of the system at 220 volts while larger motors are supplied from the outer mains at 440 volts.

Multiple Way (Telegraph) System. Any system in which more than one message is sent out simultaneously.

Multiple Winding. See LAP WINDING.

Multiplex (Telegraph) System. A system whereby more than two messages can be sent over the same circuit simultaneously. One such system depends upon the use of rapidly revolving contact arms at the two stations driven at exactly the same speed and in step with each other whereby successive contact is made with a number of local circuits. Cf. DUPLEX, DIPLEX and QUADRU-
PLEX.

Multiplex System: Baudot, Delaney, Diode, Hexode, Mercadier Magunna, Morse, Pentode, Printing, Tetrode, and Triode. See BAUDOT MULTIPLEX SYSTEM, DELANEY MULTIPLEX SYSTEM, etc.

Multiplex Winding. An armature winding comprising more than two parallel paths per pole through the winding from the positive to the negative brush or terminal. The degree of *Multiplicity*, i.e. whether the winding is simplex, duplex, triplex, etc., is independent of its degree of re-entrancy, i.e. whether the circuit closes upon itself every time it follows round. See RE-ENTRANT WINDING.

Multiplicity. See MULTIPLEX WINDING.

Multiplier: Schweigger's, Secondary Electron, and Voltage. See SCHWEIGGER'S MULTIPLIER and SECONDARY ELECTRON MULTIPLIER.

Multiplying Power (of a Galvanometer Shunt). The factor by which the current corresponding to the reading of a shunted galvanometer has to be multiplied to arrive at the total current.

Multipolar Dynamo, Generator, Motor, etc. A dynamo electric machine having more than one pair of poles to the field magnet system. Cf. BIPOLAR.

Multi-Pole Switch, Circuit-Breaker, etc. A switch, etc. constructed to break two or more poles of a circuit simultaneously.

Multi-Speed Motor. See CHANGE SPEED MOTOR.

Multi-stage Amplifier. A *Thermionic Amplifier* consisting of several valves in *Cascade* to produce a cumulative effect.

Multitone Transmitter. A wireless transmitting apparatus of the singing spark class in which by variations of the inductance of a circuit resonating with the spark or audio-frequency, variations can be made at will in the tone or note of the signals.

Multi-Turn Current Transformer. A current transformer in which the primary consists of more than one turn. Cf. BAR-TYPE CURRENT TRANSFORMER.

Multi-Valve Amplifier. See MULTI-STAGE AMPLIFIER.

Multi-Vibrator. An apparatus consisting of suitably connected thermionic valves for producing high frequency oscillations for standardising and experimental purposes at a number of frequencies which are harmonics of a fundamental frequency controlled by a tuning fork.

Multivoltage Control. The obtaining of different running speeds in a motor by connection of the armature to the different conductors at different voltages with or without intermediate speed variation by field regulation.

Multi-Way Switch. A switch in which contact can be made with a number of alternative contacts giving different paths for the current.

Multi-Way (Telegraph) System. See MULTIPLE WAY SYSTEM.

Multi-Wire Aerial. An *Aerial* in which several parallel wires, fixed a short distance apart, are used to obtain greater capacitance than would be produced by a single wire, e.g. a CAGE AERIAL.

Mumetal. ("μ" Metal.) A magnetic alloy of specially high permeability and low hysteresis, used in loaded submarine cables, for moving iron instruments and other purposes, consisting of about 75 per cent nickel, 25 per cent iron, and small quantities of copper and manganese.

Murray Loop Test. A *Wheatstone's Bridge* method of localizing a fault in a cable by replacing two arms of the bridge by a loop formed by the cable under test and a return cable from its far end and earthing

one end of the battery. The ratio of the two bridge arms on balance then gives the ratio of the resistances of the portions of the cable loop on each side of the fault, from which its position may be found. See also RAPHAEL BRIDGE.

Murray Printing Telegraph System. A type printing telegraphy system in which the message is first punched in a special code on a paper strip which is put through a transmitting instrument similar to a Wheatstone transmitter. The received signal currents actuate a punching mechanism which reproduces the original strip, and this new strip is passed through the printing instrument where a mechanical selecting device causes the correct letter to be printed. The system is adapted to a very high speed working, and can be arranged to work on a multiplex system so as to actuate several instruments printing different messages simultaneously, by synchronous revolving selectors.

Mush. A term used in wireless telegraphy and telephony for irregular disturbing radiation, due to various causes, and, in particular, produced by arc transmitters, causing a rushing sound in receiving telephones.

Mush Winding. A Winding in which the layers are not definitely spaced one over another.

Mush-Wound Coils. Coils forming a stator or rotor winding which are inserted wire by wire into partially closed ready-lined slots, the projecting portions of the coils being afterwards insulated.

Mushroom. An irregular projection formed on the negative carbon in an arc and interfering with its proper burning, especially in heavy current arcs, due partly to impurities in the electrodes.

Musical Arc. See DUDELL ARC.

Musical Instruments (Electric). Instruments in which musical notes are produced by means of electrically produced audio-frequency oscillations. See ETHEROPHONE, ETHONIUM, ELECTRONIDE, TRAUTIONIUM, and SPHEROPHONE.

Musical Spark. A spark discharge of a regular frequency within the limits of audition; used in some systems of wireless transmission to produce a singing note of constant pitch in the receiving telephone; also called *Singing Spark*.

Mutator. A term proposed to cover all applications of a grid-controlled mercury vapour discharge apparatus whether used as a *Rectifier*, *Inverter*, *Frequency-Changer*, or *Phase Changer*.

Mutual A.C. Conductance (of a Thermionic Valve). The ratio of a small change of anode current to the corresponding change in grid voltage, all other quantities remaining constant; also called *slope*. Symbol: g_m .

Mutual Impedance. A property of two neighbouring circuits analogous to *Mutual Inductance* which determines the effect of the rate of change of current in one on the rate of change of current in the other taking into account all other contributory components as well as *Inductance*.

Mutual Inductance. The property of a pair of circuits in virtue of which *Mutual Induction* exists between them, measured by the rate of change of flux linkage in one caused by unit change of current in the other. Symbol: M . Practical Unit *Henry*.

Mutual Induction. The Production of an e.m.f. in a circuit by a change in the magnetic flux linking it, due to a change of current in a neighbouring circuit. Cf. *SELF INDUCTION* and see *MUTUAL INDUCTANCE*.

Mutual Induction, Coefficient of. See *MUTUAL INDUCTANCE*.

M.V.A. Abbreviation for *Megavolt-amperes*.

Mycalex. A moulded insulating material consisting of ground mica, and lead borate or soft glass.

Myria- Prefix meaning ten thousand times.

Myriahertz. A unit of frequency equal to 10,000 hertz (i.e. 10 kilocycles per sec.) Suggested by the Union Internationale de Radiophonie, as the minimum difference of frequency for broadcasting stations.

N.]

[Neg

N. Number of revolutions per unit of time.

Nagaoka's Formula. The inductance of a single layer coil of n turns of length l and diameter d cm., is $\pi^2 d^2 n^2 / l K$, when K is a factor depending on d/l and having values of 1.0, 0.068, 0.526, 0.320, and 0.203 for values of d/l by 1, 2, 5, and 10 respectively.

Napier. The transmission unit now usually known as the *Néper*.

Narrow Gauge Motor. A traction motor specially designed for use in narrow gauge locomotives, etc., where there is insufficient lateral clearance for a motor of ordinary design.

National Electric Code. A set of regulations, established in the U.S.A. by the American National Board of Fire Underwriters, for ensuring safety in electrical wiring and apparatus.

Natural Frequency. The frequency of natural oscillations in a circuit, equal, when the resistance of effect is negligible, to $1/2\pi\sqrt{LC}$, when L = the inductance and C the capacitance of the circuit. Symbol: f_0 .

Natural Magnet. See **LODESTONE**.

Natural Oscillations. Oscillations in a circuit at a frequency entirely dependent on the electrical constants of the circuit. Cf. **FORCED OSCILLATIONS**.

Natural Rectifier. A mineral or chemical substance having a much greater resistance to currents in one direction than to those in the other, e.g. certain crystals used as detectors in wireless reception.

Natural Wavelength. The wavelength corresponding to the natural frequency of oscillation of a circuit, apart from any forced oscillations that may occur. The natural wavelength of an aerial not loaded with extra capacitance or inductance is about four times its length.

Needle. The magnetised part of the moving system of a compass, galvanometer, or similar instrument of the moving magnet type, or, in the case of some electrostatic instruments, the portion moving in the electrostatic field.

Needle: Astatic, Compass, Dipping, Induced, and Magnetic. See **ASTATIC NEEDLE, COMPASS NEEDLE**, etc.

Needle Instrument. A telegraph receiving instrument giving visual signals by the deflection of one or more pivoted needles. See **SINGLE NEEDLE** and **DOUBLE NEEDLE INSTRUMENTS**.

Needle-point Gap. A spark gap with fine pointed electrodes. See **NEEDLE POINT VOLTAGE**.

Needle-point Voltage. The voltage required to spark across a gap between needle points a given distance apart. See **SPARKING VOLTAGE**.

Negative Attenuation. A term used in connection with the strength of wireless signals for the increase in the product of amplitude and distance with increasing distance which sometimes occurs within 10 miles or so of a transmitting station.

Negative Automatic Volume Control. A similar arrangement to *Automatic Volume Control* but acting in the opposite direction, i.e. to increase the amplification of loud signals used in radiogramophones to increase contrast when playing from records.

Negative Bias. See **GRID BIAS**.

Negative Booster. A series wound booster giving a voltage roughly proportional to the current flowing, for compensating for the voltage drop in the negative or return circuit of a tramway system, etc., in order to keep the difference of potential between the rails and earth within such limits that trouble will not arise through stray

return currents causing damage to water pipes, etc., by electrolysis.

Negative Carbon. The carbon in a direct current arc lamp connected to the negative side of the circuit; usually of smaller diameter than the positive carbon (in which the *Crater* forms), on account of its burning away less rapidly and being liable to obstruct the light from the crater. Cf. **POSITIVE CARBON**.

Negative Charge. The quantity of negative electricity contained by a negatively electrified body. See **NEGATIVE ELECTRIFICATION**.

Negative Current. An expression to be avoided, but sometimes used: (1) When an electric current was considered as being made up of two components composed respectively of positive and negative electricity flowing in opposite directions for that from the negative pole. Cf. **POSITIVE CURRENT**. (2) In telegraphy for a current in the reverse direction to that making the signals. See **SPACING CURRENT**. (3) The return current in an earthed railway or tramway system.

Negative Electricity. Electricity of the kind producing the phenomena of *Negative Electrification* and opposite in properties and capable of neutralising positive electricity. At one time regarded as an entirely different entity from positive electricity (see **TWO FLUID THEORY**); or as a deficiency of a one and only kind of electricity known as positive (see **ONE FLUID THEORY**). Modern theory points to an opposite view in that it is now regarded as an excess of *Electrons* or units of *Negative Charge* within the atoms of the body carrying the charge while positive electricity is a deficiency thereof.

Negative Electrification. The production in a body of a *Negative Charge*, e.g. by the friction of resinous substances, such as sealing wax upon wool or fur (see **RESINOUS ELECTRICITY**); or by induction from a positive charge. Apart from its powers of attraction for positively charged bodies, a state of negative electrification can be

distinguished from positive electrification by differences in the form of the brush discharge and in the discharge in a exhausted tube and by characteristic forms assumed by *Lichtenberg Figures*. See also **NEGATIVE POLE** and cf. **POSITIVE ELECTRIFICATION**.

Negative Electrode. In a primary cell the plate (usually *Zinc*) by which, according to the original conventions, the current was regarded as entering the cell; in electrolytic cells, arc lamps, vacuum tubes and other apparatus, the conductor connected to the negative pole of the apparatus supplying the current.

Negative Electron. See **ELECTRON**.

Negative Element. An expression sometimes used for the electrode of a primary cell from which the current flows inside the cell, i.e. what is called the *Positive Electrode* or *Pole* from the point of view of what happens outside the cell; generally of copper or carbon.

Negative Feeder. A feeder connected to the negative side of the system; more particularly in traction systems with earthed negative for a feeder connecting the rails with the station, to avoid undue potential drop through the earth return which might produce electrolytic damage to water pipes, etc.

Negative Glow. The luminous portion of the discharge in a discharge tube, which in moderately exhausted tubes is close up to the negative electrode, but as the degree of exhaustion becomes higher than about 1/2000 of an atmosphere, is separated from the cathode by the widening *Crookes Dark Space*. Cf. **POSITIVE COLUMN STRIÆ**, **FARADAY DARK SPACE**, etc.

Negative Glow Oscilloscope. See **OSCILLOSCOPE**.

Negative Ion. An atom or molecule to which electrons detached from other atoms have been attached in the process of *Ionisation*, and therefore carry a negative charge. Cf. **POSITIVE ION**.

Negative Main. The supply main connected to the negative bus-bar

in a generating station or sub-station.

Negative Plate. The negative electrode of a primary, or more usually of a secondary cell. In the case of a lead accumulator, distinguishable from the positive plate by its grey colour. See also **NEGATIVE POLE**.

Negative Plate, Box Type or Cage Type. See **BOX TYPE NEGATIVE PLATE**.

Negative Pole. In a generator, cell, or system of supply, the terminal from which, according to the original convention, the current was regarded as returning to the source, i.e. the zinc plate in a *Daniell Cell*. In apparatus where current is utilised, the terminal connected to the negative terminal of the pole of the generator or system. It should be noted that in the case of an accumulator both these definitions apply, as the negative pole is connected to the negative pole of the generator during charging and remains the negative pole by which the current returns to the cell on discharge.

Negative Retroaction. The effect of coupling between valve circuits in wireless receiving apparatus in a direction tending to suppress self-oscillation.

Negative Resistance. A term sometimes applied to the state of affairs in an arc, vacuum tube, or other apparatus when a rise of c.m.f. produces a fall in current.

Negative Spectrum. A spectrum similar to the *Mass Spectrum* (*Positive Rays*) but obtained by rays composed of negatively-charged particles.

Negative Wire (in Telephony). The wire forming that side of a telephone line, within the exchange, normally connected to the negative side of the battery.

Negative Work. During certain parts of the cycle, in cases of an alternating current displaced in phase from the voltage, the instantaneous values of the current and voltage are of opposite sign, therefore their product, the instantaneous watts, is negative; under these conditions the circuit is

giving back energy to the generator and it is said that "negative work" is being done.

Negatron. (1) A *Negative Electron*. (2) A form of *Thermionic Valve* with four electrodes. So called because it has the effect of a negative resistance.

Neon Detector. See **NEON TUBE RECTIFIER**.

Neon-Electric Stroboscope. An apparatus for the study of the relative positions of the parts of moving machinery, etc., by the intermittent light of a neon lamp caused to light up intermittently by the discharge of a condenser the voltage of which builds up gradually between the flashes to the critical value at which the tube discharges. See **STROBOSCOPE METHOD**.

Neon Induction Lamp. A form of neon lamp suitable for *Airway Beacons* on account of its good fog penetrating properties; consisting of a small bulb containing neon at a low pressure, without electrodes, surrounded by a coil of a few turns, carrying high-frequency currents obtained from a thermionic oscillator or otherwise.

Neon Lamp. A *Gas Discharge Lamp* containing a mixture of gases, chiefly consisting of neon, at a pressure of about 0.015 atmospheres, adaptable to ordinary supply pressures and used on account of its very low current consumption for pilot lights, signals, and electric signs. The glow, which is of a characteristic orange colour, only takes place above a certain critical voltage. Long tubular lamps for signs are made on the same principle and require about 200 volts per ft. of tube.

Neon Lamp, Hot Cathode. See **HOT CATHODE NEON LAMP**.

Neon Tube. See **NEON LAMP** and **NEON TUBE RECTIFIER**.

Neon Tube Peak Voltmeter. An arrangement for measuring *Peak Voltages* in which the proportion of the voltage across a condenser potential divider applied to a neon tube is gradually increased until the known striking voltage at which the tube just lights up is reached.

Neon Tube Rectifier. A rectifier consisting of a tube containing neon at a low pressure with special shaped electrodes not independently heated, in some cases provided with grid control.

Néper. A continental telephone transmission unit, equivalent to the unit of attenuation length (βl) based on the naperian logarithm of the ratio of the two currents. One néper equals 0.8686 *Bel*. See also TRANSMISSION UNIT.

Nernst Ballast. See BALLAST RESISTANCE.

Nernst Lamp. An incandescent lamp in which the *Glowor* or incandescent body consists of a strip of material composed of a mixture of oxides of metals such as zirconium, magnesium, yttrium, etc., which is conductive only at a high temperature and consequently has to be heated by an auxiliary heating coil. The heating coil is afterwards automatically cut out of circuit when the current begins to flow through the *Glowor*.

Net: Guard, Lower Capacity. See GUARD NET and COUNTERPOISE.

Network (Electrical). (1) A *Distribution Network*. (2) A combination of inductance, capacitance, and resistance arranged in a formation of recurrent closed cells for the purpose of acting as a *Frequency Filter* or otherwise modifying the constants of an electrical circuit.

Network: Balancing, Distributing, Fault-Signalling, and Retardation. See BALANCING NETWORK, DISTRIBUTING NETWORK, etc.

Neutral Auto-Transformer. An arrangement of transformers or reactors coupled in star, or otherwise, so that a neutral point is obtained on a polyphase or single-phase three-wire system.

Neutral Axis. An expression sometimes used for the diametral plane in which the brushes of a machine must be situated for perfect *Commutation*. Sometimes limited to open circuit conditions where there is no armature reaction. See DIAMETER OF COMMUTATION.

Neutral Compensator. See NEUTRAL AUTO-TRANSFORMER.

Neutral Conductor. (1) The middle wire of a *Three-Wire System*. (2) A conductor connected to the neutral point of a star connected *Three-Phase System*.

Neutral Feeder. A *Feeder* connected to the *Neutral Conductor* of a distributing system.

Neutral Line. See NEUTRAL AXIS (of Commutation).

Neutral Main. See NEUTRAL CONDUCTOR.

Neutral Point. (1) Of a supply system. A point which has the same potential as the junction of a set of equal resistances connected to all the main conductors of the system, usually at earth potential on a balanced system. (2) The point on a commutator intersecting the *Neutral Axis*.

Neutral Position. The position of the brushes in a machine where there is no voltage between the commutator segments. Usually used for open circuit conditions where there is no armature reaction and no backward or forward lead.

Neutral Relay. A *Relay*, the armature of which moves in different directions for different directions of current.

Neutral Temperature. The temperature at which the thermoelectric curves for two metals cross, i.e. the temperature of the hot junction at which maximum current flows between them, or the average temperature for the two junctions above which the current is in one direction and below which it is in the other. In the case of copper and iron the neutral temperature is about 270° C.

Neutral Wire. See NEUTRAL CONDUCTOR.

Neutral Zone. An expression sometimes used for the portion of a magnetic field where the forces due to the two poles are equal, or for the *Neutral Axis* of commutation.

Neutralator. See NEUTRAL AUTO-TRANSFORMER.

Neutralised Series Motor. A *Single-Phase Series Motor* provided with a coil on the stator at right angles to the exciting coil to neutralise

the effect of the inductance of the armature.

Neutralising Condenser. See *Neutrodyne Reception*.

Neutralising Transformer. A transformer for producing, in a telephone circuit, a voltage proportional to, and opposing, that induced by a neighbouring power line.

Neutrino. A hypothetical entity of zero mass and zero magnetic moment, but the same spin as an electron.

Neutrodon. A neutralising condenser used in *Neutrodyne Reception*.

Neutrodyne Reception. A form of wireless reception with high-frequency amplification in which oscillation is prevented by reactances in the anode and grid circuits or other similar methods, to neutralise the coupling effect of valve and stray capacitance.

Neutron. The name given to the kind of particle with zero charge radiated by such substances as beryllium when bombarded by alpha particles, consisting of uncharged particles of the same mass as a hydrogen nucleus. This is the most penetrating form of radiation known.

Neutrosomic Reception. A system of wireless reception incorporating the principles of *Superheterodyne Reception* with neutralisation of the intermediate frequency stages as in *Neutrodyne Reception*.

Nichrome. An alloy containing nickel and about 20 per cent of chromium, used for heating elements, which can remain at a bright red heat for extended periods.

Nickel-Cadmium Accumulator. An *Alkaline Accumulator* with nickel hydroxide and cadmium oxide for the positive and negative active materials respectively.

Nickel Facing. The electrodeposition of a protective coating of nickel upon stereotypes for printing.

Nickel-Iron Accumulator. See *EDISON ACCUMULATOR*.

Nickel Plating. *Electrodeposition* of nickel for industrial purposes.

Nicore. A material similar to that described under *Dust Core* but

with nickel as the magnetic material.

Night Error (in *Wireless Direction Finding*). A variable error in the observed bearing, probably due to the fact that in night reception an abnormally polarised indirect wave (reaching the receiver in a downward direction from the *Heavyside Layer*) is superposed on the direct *Normally Polarised Wave*.

Nine-Ring Converter. A *Rotary Converter* working with nine-phase current, and therefore with nine slip rings.

Nitrogen, Fixation of. See *FIXATION OF NITROGEN*.

Nitrogen-Filled Lamp. See *GAS-FILLED LAMP*.

Nobili's Rings. Coloured interference rings exhibited by very thin films of peroxide of lead deposited upon a polished anode when a solution of a lead salt is electrolysed.

Noctovision. A process similar to *Television*, employing invisible infra-red rays in the transmitting apparatus, forming the equivalent of "seeing in the dark."

Noctovisor. An apparatus for *Noctovision*.

Nodes. The zero points of a series of *Stationary Waves* or oscillations in a conductor. Cf. *ANTINODES*.

Nodon Valve. An *Electrolytic Rectifier* with a cathode consisting of an aluminium rod, an anode formed by a lead containing vessel and an electrolyte of ammonium phosphate. A high current density is employed at the cathode.

Noegerrath Dynamo. A form of unipolar generator with an armature containing several conductors which are put in series by a number of slip-rings and brushes.

Noise (in *Telephone Engineering*). All disturbing sounds audible in a receiver other than the speech required to be transmitted.

Noise: Johnson, Line, Microphonic, Terminal, and Valve. See *JOHNSON NOISE, LINE NOISE, etc.*

Noise Analysis. Determination of the frequencies of the constituent harmonics of a telephone *Noise*.

Noise Generator. An apparatus, of the vibrator or inductor alternator

type, for producing audio-frequency currents of known magnitude in connection with *Noise Measurement*.

Noise Measurement. The quantitative estimation of telephone *Noise* in arbitrary units, by means of a "Noise Measuring Set," in which a comparison is made by means of a potentiometer arrangement with a standard *Noise Generator*.

Noise Measuring Set or Noise Meter. See *NOISE MEASUREMENT*.

No-Load Characteristic. A curve exhibiting the relation between excitation and voltage, or any other two quantities relating to a machine or apparatus, under *No-Load* conditions. Also called *Open Circuit Characteristic*.

No-Load Conditions. The conditions when a machine, transformer, etc., is giving its voltage but no current is being taken from it other than that required to make up losses, or when a motor is running but not giving useful power.

No-Load Current. The current taken by a motor, transformer, or other apparatus to overcome losses under *No-Load Conditions*.

No-Load Losses. The energy losses in a machine, transformer, etc., under *No-Load Conditions*, such as those mainly due to hysteresis in a transformer.

Non-Ageing Steel. Steel plate for transformer cores not liable to deteriorate in magnetic property after prolonged use in a transformer. See *AGEING*.

Non-Arcing Arrester. A form of *Arrester* in which the gaps (usually a number in series) are between cylinders of a *Non-Arcing Metal*.

Non-Arcing Metal. A metal, such as zinc or aluminium, electrodes of which only support an arc with difficulty; used for arrester gaps, high tension fuses, etc.

Non-Association Cable. Cable not in accordance with the standard of the Cable Makers Association.

Non-Combustible Covering. Covering for cables, etc., which resists high temperatures without deterioration or burning away. Cf. *NON-INFLAMMABLE COVERINGS*.

Non-Conductor. A body which is of

sufficiently high resistance not to permit of an appreciable flow of current through it, i.e. an *Insulator*.

Non-Electric. See *AN-ELECTRIC*.

Non-Inductive Circuit. A circuit having negligible *Inductance*.

Non-Inductive Load. A load on an a.c. supply system, generating station, etc., in which the apparatus connected to the circuit is of negligible inductance, and therefore of power-factor approximating to unity, such as a load consisting entirely of lighting without induction motors. (This expression does not take into account the possibility of a *Leading Load*, and therefore the term *Non-Reactive Load* is preferable.)

Non-Inductive Resistance or Resistor. A resistance wound or constructed so that it possesses negligible inductance.

Non-Inflammable Covering. Covering of cables, etc., which will not burn so as to cause extension of a fire, but not necessarily entirely undamaged by heat. Cf. *NON-COMBUSTIBLE COVERING*.

Non-Linear Distortion. Distortion of received signals in which the alterations of the quantities in question are not independent of the amplitudes, including the introduction of parasitic frequencies by apparatus in the circuit.

Non-Linear Distortion Factor. A measure of the degree of *Non-Linear Distortion* in a telephone circuit, etc., being the ratio of the total power in the circuit due to frequencies other than present in the parent tone to the total power in the circuit.

Non-Magnetic Materials. Materials which do not show the marked magnetic properties such as those of iron, nickel and cobalt.

Non-Magnetic Steel. An alloy steel containing about 12 per cent of manganese and sometimes a small amount of nickel, practically non-magnetic at ordinary temperatures.

Non-Magnetic Watch. A watch specially constructed so as not to be liable to damage in a magnetic field; usually with a balance spring of a non-magnetic material

such as palladium. See DEMAGNETISATION OF WATCHES.

Non-Overlapping Winding. An alternator armature winding in which the individual coils are placed side by side without overlapping.

Non-Polar Generator. A name sometimes given to *Homopolar* or *Unipolar* generators.

Non-Polarised Relay. A relay which acts equally with currents in both directions. Cf. **POLARISED RELAY**.

Non-Reactive Load. A load with unity power-factor.

Non-Resonating Transformer. A transformer in which the end turns of the h.t. winding are provided with a metal screen connected to the line end of the winding to minimise the effect of steep fronted surges.

Non-Sine-Waves. Waves of e.m.f., current, etc., which depart from a true sine form. Cf. **SINE WAVES**.

Non-Synchronous (Motor, etc.). See **ASYNCHRONOUS MACHINE**.

Non-Tension Joint (in an Overhead Conductor). A joint designed to carry the full current but not to take mechanical tension. Cf. **TENSION JOINT**.

Normal Bend. A right-handed bend of moderate radius for joining two lengths of conduit tube. Cf. **HALF-NORMAL BEND**.

Normal Charging Current (in a Condenser). The current rush flowing into a condenser while receiving its charge (representing energy recovered in the *Normal Discharging Current*), in addition to the *Anomalous Charging Current*, the *Normal Conduction Current* and the *Anomalous Conduction Current*.

Normal Conduction Current (in a Condenser). The current due to leakage, continuing through a condenser after the rush of *Normal Charging Current* has ceased, as long as a continuous e.m.f. is applied.

Normal Coupling. The coupling of wireless circuits where the capacitance and inductive coupling effects act in the same direction. See **ORTHODYNE CIRCUIT**.

Normal Current. See **NORMAL RATING**.

Normal Discharge Current (in a Condenser). The current flowing out of a condenser when discharging, in addition to any *Anomalous Discharge Current*, ceasing as soon as the main discharge is complete and representing the energy of the *Normal Charging Current*.

Normal Electrode. An electrode for immersing into an electrolyte for measuring electrode potentials; of a material giving a known potential difference between itself and the electrolyte. See **CADMIUM**, **CALOMEL**, and **HYDROGEN ELECTRODES**.

Normal Output. See **NORMAL RATING**.

Normal Rating. The definition of the output which a machine, etc., is designed to give or the voltage, current, etc., which it is designed to deal with under ordinary working conditions. See **CONTINUOUS RATING**, **INTERMITTENT RATING**, etc.

Normal Sensitivity or Sensitiveness. See **FACTOR OF MERIT**.

Normal Voltage. See **NORMAL RATING**.

Normally Polarised Waves. *Electric Waves* in which the magnetic component is horizontal and at right angles to the plane of propagation. Cf. **ABNORMALLY POLARISED WAVES**.

North, Magnetic. See **MAGNETIC NORTH**.

North Pole. (1) Of the earth: either the true geographical north pole or the *Magnetic North* pole. (2) Of a magnet: the pole which tends to point towards the north when freely suspended, i.e. the *North Seeking Pole*.

North Pole, Magnetic. See **MAGNETIC NORTH POLE**.

North Seeking Pole. See **NORTH POLE** (2).

Northern Lights. See **AURORA BOREALIS**.

Northrup Furnace. A type of *Induction Furnace* without any iron core, employing frequencies over 10,000 cycles per second.

Nose Suspension (of a Traction Motor). Suspension in which part of the weight of the motor is spring-borne by a lug on the side of the frame away from the axle, and the remainder is supported by the axle itself through bearings on it. (Also

called *Wheelbarrow Suspension*.) Cf. *YOKE SUSPENSION*, *SIDE-BAR SUSPENSION*, etc.

Notches (of a Controller). The various positions of a controller handle corresponding to the different combinations of connections between the motors and resistances.

Notch(es): Braking, Full Parallel, Full Series, Parallel, Resistance, Running, and Series. See *BRAKING NOTCHES*, *FULL PARALLEL NOTCHES*, etc.

Note Amplifier or Note Magnifier. A thermionic *Amplifier* in the low-frequency or audio-frequency circuit of a wireless receiving apparatus; strictly speaking, applicable only to wireless telegraphy but sometimes used for any low-frequency amplifier, including a speech amplifier in wireless telephony.

Note Tuning. Tuning a circuit to respond to an audio-frequency.

No-Voltage Circuit-Breaker, Relay, etc. A circuit breaker, relay, etc., which comes into action and breaks the circuit when the voltage fails.

No-Voltage Release (to a Starter). A device which causes a motor-starter to fly back into the off position if the voltage fails; usually in the form of a holding-on electro-

magnet connected, in series with a resistance, across the mains. This attracts an armature on the switch arm, and holds it in the full-on position, unless released by failure of the voltage. See also *OVERLOAD RELEASE*.

Nuclear Theory (of Atomic Construction). The conception of an atom as consisting of a central positively charged *Nucleus* of minute dimensions but considerable mass surrounded by a number of "satellite" electrons at a relatively great distance therefrom. See *ELECTRON* and *PROTON*.

Nucleus. The positively charged central portion of an atom, according to the nuclear theory; composed of one or more *Protons* with or without a certain number of *Neutrons*.

Null Method. See *ZERO METHOD*.

Number, Atomic. See *ATOMIC NUMBER*.

Numerical Selector. A selector in automatic telephony which establishes connection with further selectors or with the required line according to one or more digits in the number dialled. Cf. *CODE SELECTOR*, and see *HUNDREDS SELECTOR* and *THOUSANDS SELECTOR* and *FINAL SELECTOR*.

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Obach Cell. A *Dry* (primary) *Cell* with a central carbon rod as positive electrode surrounded by a depolariser paste of manganese dioxide and ground carbon, and with an exciting paste of salomniac, plaster of Paris and flour, in contact with the outer zinc cylinder which forms the negative electrode.

Octode. A *Thermionic Valve* with eight electrodes, usually for combining the functions of two valves, e.g. a six-grid frequency changer in a superheterodyne receiver which combines an oscillator with a *Variable-Mu Pentode* mixer valve.

Octuple Phantom Circuit. A superposed circuit each side of which consists of the sixteen conductors of a *Quadruple Phantom Circuit* in parallel.

Oersted. A name originally proposed for the unit of Magnetic Reluctance, but now adopted for the unit of *Magnetising* or *Magnetic Force*; named after the Danish physicist, H. C. Oersted (1777-1851).

Oersted's Principle. The deflection of a magnetic needle by a current in a neighbouring wire; discovered by him in 1820.

Ohm. The *Practical Unit of Resistance*, named after the German physicist, G. S. Ohm (1787-1854). The true Ohm is 10^9 C.G.S. absolute electromagnetic units of resistance. See also *INTERNATIONAL OHM*. Abbreviation: Ω .

Ohm : B.A., Board of Trade, B.O.T., British Association, International, Legal, Thermal, True, and Standard. See B.A. OHM, BOARD OF TRADE OHM, etc.

Ohmic Drop. The potential drop between two points in a current-carrying conductor, due to its resistance (*IR Drop*) as distinguished from drop due to other causes such as *Inductance*.

Ohmic Loss. *Energy Loss* in a current-carrying conductor due to heating owing to its resistance ($I^2 R$ Loss).

Ohmic Resistance. The true resistance of a conductor, equal to that which it offers to an unvarying current. Cf. *IMPEDANCE*.

Ohmmeter. An electrostatic form of *Ohmmeter* forming a portable testing set.

Ohmmeter. An instrument for measuring resistance by direct deflection, usually one in which the moving system is deflected by forces due to currents in two coils at right angles to one another, carrying currents proportional respectively to the current through the conductor under test and the potential drop across it. Used in conjunction with a magneto generator giving a few hundred volts for testing insulation resistance (see *MEGUER*) and in some forms of *Resistance Thermometer*.

Ohmmeter, Magneto. See *MAGNETO OHMMETER*.

Ohm's Law. The law of the flow of unvarying currents, whereby the strength of the current varies directly as the electromotive force and inversely as the resistance of the circuit; usually expressed in symbols as $I = E/R$ where I is the current (in amperes), E is the electromotive force (in volts) and R is the resistance (in ohms).

Oil: Insulating and Transformer. See *INSULATING OIL* and *TRANSFORMER OIL*.

Oil-Blast Circuit-Breaker. A modification of the *Explosion Pot* type of *Circuit-Breaker*, in which the pressure produced by the initial break causes clean oil to be forced into the arc at a secondary break. In another form the oil-jet is produced by the release of a spring pump-piston.

Oil-Break Circuit-Breaker. An *Oil-Break Switch* fitted with some form of release gear.

Oil-Break Fuse. A fuse in which the break of the circuit caused by the melting of the fuse wire or strip is effected under oil to extinguish the arc.

Oil-Break Switch or Oil-Switch. A switch in which the contacts are separated under oil for the quick and effective extinction of the arc, used chiefly for high voltage alternating currents, but also to a limited extent for direct currents.

Oil-Circuit-Breaker. See **OIL-BREAK CIRCUIT-BREAKER**.

Oil-Cooled Transformer. An oil transformer in which provision is made for circulating the oil and passing it through a separate cooler.

Oil-Filled Cable. Cable in which the whole of the interstices between conductors, coverings, etc., are filled with oil retained by an external tube with oil-tight joints, expansion chambers, etc. See also **GAS PRESSURE CABLE**.

Oil-Fuse. See **OIL-BREAK FUSE**.

Oil-Immersed Apparatus. Electrical apparatus immersed in oil for insulating or protective purposes, to facilitate the extinction of the arc on the intentional or accidental breaking of the circuit and to prevent the flame therefrom being communicated to outside, or to facilitate cooling by the circulation of the oil.

Oil-Insulation. The insulation of electrical apparatus such as transformers by immersion in a tank of oil. See **INSULATING OIL**, **OIL-IMMERSED APPARATUS**, etc.

Oil-Insulator. Insulators of porcelain, glass, stoneware, etc., in which the leakage path over the surface is interrupted by a surface of oil contained in a groove or trough round the insulator.

Oilstatic Cable. A variety of *Oil-Filled Cable* in which a steel pipeline forms the containing vessel.

Oil-Quenched Cut-Out or Fuse. See **OIL-BREAK FUSE**.

Oil-Switch. See **OIL-BREAK SWITCH**, **CIRCUIT-BREAKER**, etc.

Oil-Transformer. A transformer in which the whole of the coils,

core, etc., are immersed in oil, cooled by the natural or forced circulation of the oil or by pipes within the oil tank through which cooling water circulates. See **OIL-IMMERSED APPARATUS**, **TRANSFORMER OIL**, etc.

Omega (Ω). Abbreviation for *Ohm* (ω) symbol for *Angular Velocity*.

Omni-Aerial. An aerial radiating at equal strength in all directions in the same angle with the horizontal.

Omnibus (Electric). A road vehicle for carrying a number of passengers propelled by electric motors deriving their energy from accumulators carried on the vehicle. Sometimes also used for road vehicles of this kind not running on rails deriving their energy from an overhead contact wire system. See **TROLLEY-OMNIBUS**.

Omnibus, Trolley. See **TROLLEY-OMNIBUS**.

Omnibus Bars. Main conductors on a switch-board forming common terminals to which a number of generators or feeders are connected; commonly called *Bus-Bars*. See **GENERATOR BUS-BARS**, **FEEDER BUS-BARS**, **RING BUS-BARS**, **SECTIONALISED BUS-BARS**, etc., and **BAR-COUPLING PANEL**.

Omnigraph. An apparatus used in teaching the Morse code, which consists of a disc with contacts so arranged that when rotated it produces Morse signals in a buzzer circuit to which it is connected.

Omni-Radio Beacon. A *Radio-Beacon* radiating its distinguishing signals equally in all directions.

Ondameter. See **WAVE METER**.

Ondograph (Hospitalier). An instrument for drawing alternating wave-form curves by a step-by-step method. A commutator driven through gearing by a synchronous motor connects a condenser momentarily to the circuit once in every hundred waves at successive points a little further along the wave each time. The condenser is discharged each time into a recording galvanometer which traces the required curve on a drum.

Ondoscope. A glow discharge tube

used as an indicator of electric waves. See NEON TUBE.

One-Fluid Theory. The theory of electrostatics by which positive electricity was regarded as an excess of electric fluid and negative electricity as a deficiency of the same fluid. Cf. TWO-FLUID THEORY. Modern views regard negative electricity, carried in indivisible units called electrons, as the foundation of all electrical phenomena. See ELECTRON THEORY.

One-Hour Rating. The rating of traction motors, etc., by the output which they can give continuously for one hour starting from cold at their normal voltage. Usually under test conditions on a stand with ventilating covers removed to approximate to the cooling conditions of running on a train, etc., and including gearing losses if any.

One-Meter Battery System. A system of measuring the charge and discharge of an accumulator battery in which a single amper-hour meter is used, which reads forward for currents in one direction and backward for currents in the other direction. Cf. TWO-METER BATTERY SYSTEM.

One-Phase. An expression occasionally used for *Single-Phase*.

One-Pole Method. The *Magnetometer Method* of iron testing in which the specimen is a very long rod or wire placed relatively to the magnetometer so that the distant pole has practically no effect.

One-Range Winding. See RANGE.

One-to-One Transformer. A transformer with equal primary and secondary windings for exchanging power without change of voltage between circuits which it is desired to keep insulated from one another.

One-Valve Receiver. See VALVE RECEIVER.

One-Wave Rectification. See HALF-WAVE RECTIFICATION.

One-Way Switch. A switch with only one path for the current. Cf. TWO-WAY and MULTIWAY SWITCHES.

On-Load Tap Changer. A *Tap Changer* for a transformer which can be operated during full load conditions.

Opal Lamp. An incandescent lamp with a bulb of opal glass to diffuse the light.

Opal Shade. The ordinary shade of opalescent glass, used with incandescent lamps to improve the light distribution.

Open. A switch, circuit-breaker, etc., is said to be open when the conductors are separated so that current cannot pass. (Unlike a water-tap, which is said to be "open" when the current of water can pass.) Cf. CLOSE.

Open Arc Lamp. The ordinary form of arc lamp, in which access of the external atmosphere is not prevented by an enclosing globe round the arc; the only globes being for light diffusion or protection from draught. Cf. ENCLOSED ARC LAMP.

Open Circuit (1) A system of conductors, intended to carry a current, temporarily interrupted so that no current can flow. A machine, transformer, etc., is said to be on open circuit when giving its normal voltage but no current to the circuit which it is arranged to supply. See also OPEN CIRCUIT SYSTEM.

Open Circuit Characteristic. See NO-LOAD CHARACTERISTIC.

Open Circuit Control. The control of traction motors, etc., by a controller which is arranged so that the current is interrupted each time the connections are rearranged when passing from one step to another. Cf. BRIDGE TRANSITION.

Open Circuit Losses. See NO-LOAD LOSSES.

Open Circuit System. A system of electric signalling, fire alarms, etc., in which the circuit is normally open when no signal is being made and the signals are made by passing currents when required. Cf. CLOSED CIRCUIT SYSTEM.

Open Circuit Winding. See OPEN COIL ARMATURE WINDING.

Open Coil Armature Winding. Armature windings, used particularly in early arc lighting machines in

which the ends of adjacent coils were not connected to the same commutator segment, but formed circuits only closed by the external circuit.

Open Core Transformer. A transformer with an air-gap in the magnetic circuit.

Open Flame Arc Lamp. A flame arc lamp in which access of the external atmosphere is not prevented by an enclosure round the arc, the only globes being for light diffusion or protection from draughts.

Open Fuse. A Fuse in which the actual *Fuse Link* is entirely uncovered.

Open Motor. A motor in which the windings, etc., are not protected by end shields and are consequently fully exposed to the cooling action of the surrounding atmosphere. Cf. PROTECTED, ENCLOSED, SEMI-ENCLOSED, ENCLOSED-VENTILATED MOTORS, etc.

Open Primary Current Transformer. See BAR TYPE CURRENT TRANSFORMER.

Open Slots. Slots for the reception of armature windings, etc., with openings of the full width of the slot, so that complete coils can be inserted without difficulty; usually employed in direct current machines, but less frequently in alternating current machines. Cf. CLOSED SLOTS, PARTLY CLOSED SLOTS, etc.

Open Sparking. An expression used with reference to electrical apparatus for coal mines, etc., to indicate sparking which, owing to lack of special provisions such as *Flame-proof* covers, could ignite inflammable gas.

Open Starter. A *Motor Starter* in which the contacts, etc., are not contained in a closed case.

Open Switchgear. Switchgear in which live parts are not covered in.

Open Type Boiling Plate. A *Boiling Plate* with the heating elements exposed to the air.

Open Wire Circuit or Line. An overhead telephone or telegraph line with each wire supported separately, as distinguished from a cable.

Operating Factor. The ratio of the

average time a motor on intermittent load is running to the average *Duty Cycle* period. Cf. DUTY-CYCLE FACTOR.

Opposition, in. See IN OPPOSITION.

Opposition Method. (1) Measurement of the internal resistance of two cells coupled in opposition so that their e.m.f.'s neutralise each other, by the ordinary *Wheatstone's Bridge* method. (2) A method of testing a pair of similar transformers in which the primary windings are connected in parallel to a circuit of the proper voltage and frequency, and the secondary windings are connected in series in opposite directions so that their voltages exactly balance and no secondary current flows in them unless an independent e.m.f. is introduced. This can be done to produce any desired secondary current, but the power required will only be that necessary to supply the losses. See also SUMPNER'S METHOD.

Optical Pyrometer. An instrument for ascertaining furnace temperatures, etc., by observing the glowing portion through a tube and comparing its brightness with a filament heated electrically. The brightness of the filament is adjusted till a balance is obtained, and the temperature is deduced from the reading of an ammeter in the filament circuit. (Also called *Disappearing Filament Pyrometer* or *Monochromatic Pyrometer*.) See RADIATION PYROMETER.

Optical Rotations. See MAGNETO-OPTICAL ROTATIONS.

Optical Stress, Electrostatic. See ELBOSTROSTATIC OPTICAL STRESS.

Optical Telephony. A form of telephony without line wires in which a beam of light (or ultra-violet or infra-red rays) is modulated by the transmitter, and falling on the distant receiver, affects a photoelectric cell so that the modulations are reproduced in the current in the receiving telephone.

Optico-Magnetic Pyrometer. A *Radiation Pyrometer* depending on the alteration of the *Susceptibility* of certain nickel alloys with temperature.

Optics, Electron. See ELECTRON OPTICS.

Ottophone. An instrument for enabling the blind to read ordinary print by means of a telephone receiver controlled by the variations in resistance of a *Selenium Cell*. The letters are intermittently illuminated in bands, each with a different frequency of illumination, and arrangements are made so that as a black part of a letter passes through one of these bands as the "eye" of the instrument travels over it, the balance between the resistance of two selenium cells is upset and a current of a frequency equal to that of the illumination of the band in question passes through the telephone receiver. Thus a definite signal consisting of a combination of consecutive and simultaneous sounds of different pitch (chords) is heard, from which, after a little training, the form of the letter is easily recognised.

Orbis Virtutis. An obsolete expression used by Gilbert for *Magnetic Field*.

Order Wire Circuit. A circuit connecting two telephone exchanges used only for asking for the connections required, but not for the subsequent conversation, and therefore available when all the ordinary junction lines are in use.

Order Wire Circuit, Split. See SPLIT ORDER WIRE CIRCUIT.

Ore Finding (Electrical). See PROSPECTING (Electrical).

Ore Separator, Electrostatic, and Magnetic. See ELECTROSTATIC ORE SEPARATOR and MAGNETIC ORE SEPARATOR.

Organ (Electric). (1) An organ in which the valves are controlled electrically, or in which the sounds are produced by oscillator currents of different frequency for each note. (2) That part or "Organ" of an electric *Bel* or other animal capable of giving electric discharges, in which the electrical action is produced; situated in the back of the head in the *Ray* or *Torpedo* and distributed along the whole body in the *Electric Bel* or *Gymnotus*;

consisting of muscular tracts with a large number of cells abundantly supplied with nerves.

Orthodyne Circuit. A circuit for a *Thermionic Oscillator* in which *Normal Coupling* is employed between the plate and grid circuits. Cf. ANTIDYNE and RHEODYNE CIRCUITS.

Orthojector Circuit-Breaker. A circuit-breaker requiring only a small quantity of oil, in an insulating container with a blow-out action produced by an enclosing chamber in conjunction with an oil jet.

Oscillating Circuit. See OSCILLATORY CIRCUIT.

Oscillating Component. A term used for an oscillating current when superposed upon a continuous current as in the plate current in a wireless receiver.

Oscillating Current. A high frequency current the frequency of which is entirely dependent on the constants of the circuit itself.

Oscillating Electrode. The coiled wire intermediate electrode in a micro-ray oscillator corresponding in construction but not in function to the grid in an ordinary triode. Cf. REFLECTING ELECTRODE.

Oscillating Meter. A meter in which the moving system executes an oscillatory motion instead of the rotary motion usual in a motor-meter; either the speed or the amplitude of the oscillation being proportional to the load.

Oscillation Circuit. See OSCILLATORY CIRCUIT.

Oscillation. The setting up or existence of continuous free oscillations in an oscillatory circuit.

Oscillation, Self. See SELF OSCILLATION.

Oscillation Constant. The property of an oscillating circuit upon which its natural frequency depends, sometimes defined as the square root of the product of the inductance and the capacitance, and sometimes as the square of this quantity. This is read directly on the scale of a *Cymometer*. (Also called *Resonance Constant*.)

Oscillation Transformer. A high frequency transformer, the primary of which is supplied with oscillating

current obtained from the discharge of a condenser or otherwise, often used in connection with tuned circuits. In wireless, a high frequency iron core transformer or *Jigger*.

Oscillation Valve. Any apparatus depending on electrolytic or ionic action which is conductive in one direction only, such as the original form of *Thermionic Valve* discovered by Fleming in 1887, consisting of a hot cathode in the form of a lamp filament from which a stream of electrons proceeds towards the anode in the form of a metallic cylinder or plate in the same bulb. Such an apparatus will conduct in the direction from the anode to the cathode only, and on account of this rectifying property can be used as a wireless receiver. See also *LODGE VALVE*, *ELECTROLYTIC RECTIFIER*, etc.

Oscillations (Electrical). The periodical surging backward and forward of electricity in a circuit, such as that produced by the discharge of a condenser through an *Oscillating Circuit*. Such oscillations, unless the cause producing them persists, decrease progressively in amplitude and die out owing to dissipation of energy partly by heating the circuit and partly by radiation in the form of electric *Waves*.

Oscillations: Continuous, Damped, Double, Dynatron, Electronic, Frequency, Forced, Fundamental, Kipp, Magnetic, Magnetron, Natural, Reactive, Swing, and Undamped. See *CONTINUOUS OSCILLATIONS*, *DAMPED OSCILLATIONS*, etc.

Oscillator. A system of conductors suitably arranged to have the properties of an oscillating circuit, usually in conjunction with some form of apparatus, such as a spark-gap, arc, or thermionic valve capable of exciting or maintaining such oscillations.

Oscillator: Blocking, Dipole, Hertz, Heterodyne, Local, Magnetostriction, Master, Piezo-Electric, Quartz, Righi, Squegger, Thermionic, and Valve. See *BLOCKING OSCILLATOR*, *DIPOLE OSCILLATOR*, etc.

Oscillatory Circuit. A circuit in which the relations of the induc-

tance and capacitance are such that it has a natural period for which free electrical oscillations are possible, i.e. where $4L$ is greater than R^2C (where L is the inductance in henries, R is the resistance in ohms, and C is the capacitance in farads).

Oscillatory Discharge. A sudden electric discharge, such as that of a condenser is not always unidirectional, but if the inductance of the circuit into which it is discharged is greater than $R^2C/4$ (where R is the resistance in ohms, and C is the capacitance in farads) the discharge executes rapid oscillations, i.e. surges to and fro at a frequency of $1/2\pi\sqrt{CL}$, decreasing in amplitude until the whole energy of the discharge is dissipated by heat and radiation.

Oscillatory Impedance. The impedance of a conductor at high frequencies where, owing to the *Skin Effect* the resistance is higher than at low frequencies.

Oscillon. A variety of *Thermionic Valve* similar to the *Audion*, but used for the production of oscillations. See *THERMIONIC OSCILLATOR*.

Oscillogram. A record of wave form made photographically or otherwise by an oscillograph.

Oscillogram, Dust. See *DUST OSCILLOGRAM*.

Oscillograph. An instrument for recording photographically or otherwise the wave form of alternating or other rapidly changing currents, voltages, etc. Usually by the action of a beam reflected by a mirror attached to a moving system subjected to forces proportional to the instantaneous value of the quantity to be measured, and sufficiently light and well damped to follow the rapid vibratory movement with accuracy.

Oscillograph: Blondel, Cathode Ray, Duddell, Electrographic, Electrostatic, Hot-wire, and Irwin. See *BLONDEL OSCILLOGRAPH*, *CATHODE RAY OSCILLOGRAPH*, etc.

Oscilloscope. An apparatus for rendering visible the wave form

of electrical oscillations or alternating currents; e.g. the Gehrcke Oscilloscope, consisting of a tube containing nitrogen at a low pressure, with two aluminium electrodes nearly touching, between which a visible discharge takes place extending a distance up the electrodes proportional to the voltage. The wave-form is seen by viewing this in a rotating mirror. The name is also used for an instrument for indicating by the length of the negative glow in an auxiliary discharge tube, the amount of current passing in an "X" Ray Tube.

Oscilloscope, Elverson. See ELVERSON OSCILLOSCOPE.

Osglim Lamp. The trade name of a form of Neon Lamp with about 20 per cent of helium added to the neon.

Oso. Trade name of a simple form of oscillograph for use as a Phonoscope.

Osmium Lamp. An early metal-filament lamp, with the filament made of the metal osmium.

Osmo-Regulator. An appliance used to regulate the vacuum in X-Ray tubes, consisting of a small mass of platinum, palladium, etc., in a branch of the tube which, when heated, gives off occluded hydrogen and lowers the vacuum when it has become too high after continued use.

Osmose, or Osmosis (Electric). The tendency of liquids to pass through a porous diaphragm towards the cathode when a current is passed through them, raising the level of the liquid on the negative side. What happens on the negative side is called *Endosmose*, and what happens on the positive side is called *Exosmose*. It is by a similar action that damp and dirt are attracted to the negative side of a d.c. installation, tending to lower the insulation, whereas the positive side tends to become drier and to improve its insulation. For this reason it is more usual to choose the negative side for earthing. A similar principle is used for the bacteriological purification of water.

Osophone. A telephone receiver designed for the use of the partially deaf by applying the vibrations direct to the bones of the head.

Ossam Lamp. The trade name for a make of metal filament lamp, the filament of which now consists entirely of tungsten (wolfram), but formerly contained osmium also. Cf. OSMIUM LAMP.

Ossiphone. See OSOPHONE.

Oudin Current. A term used in *Diathermy* for a low current at a high frequency. Cf. *d'Arsonval Current* and *TESLE Current*.

Out-of-Balance Current, Load, etc. The current which flows in the middle wire of a three-wire system when the load on one side is greater than that on the other, or in the neutral wire of a four wire three-phase system where the phases are unequally loaded.

Out of Phase and Out of Step. Two alternating currents, voltages, etc., are said to be out of phase or out of step when they do not pass through their zero values at the same instant even if their frequency and wave forms are the same.

Outdoor Substation. A substation composed entirely of *Weatherproof* transformers, switchgear, etc., not covered by a roof. Frequently employed with high tension transmission lines.

Outdoor-Type Switchgear. See WEATHERPROOF SWITCHGEAR.

Outer Conductor or Main. (1) One of the two conductors in a three-wire system between which the full voltage exists. (2) The outer layer of conducting strands in a concentric cable.

Outgoing Feeders. Feeders radiating from a generating station or substation for the supply of power. Cf. *INCOMING FEEDERS*.

Outgoing Junction Lines. A junction line from a telephone exchange for outgoing calls only. Cf. *INCOMING JUNCTION LINES*.

Outlet. An expression used particularly in America for *Wiring Point*.

Outlet Box. A terminal box through which contact can be made for fittings, switches, etc., with interior wiring buried in the wall.

Output. The power (or current) which is given out by a generator, motor, or other machine or apparatus; usually expressed in kilowatts or, in the case of a motor, in horsepower, and equal to the input minus the losses. Also sometimes expressed as the current in amperes.

Output: Normal or Rated, and Specific. See NORMAL OUTPUT and SPECIFIC OUTPUT.

Output Coefficient. The coefficient which, multiplied by the square of the diameter and the length (D^2L) of an armature core, gives the output in kilowatts per revolution per minute.

Output Transformer. A transformer used to couple a telephone receiver or loud speaker to a wireless receiver. See also INPUT TRANSFORMER.

Output Valve. A *Thermionic Valve* suitable for use in the last audio-frequency amplifying stage of a wireless receiver, i.e. for the immediate supply of the loud speaker either direct or through a transformer.

Oval Cable. Cable or elliptical instead of circular section to allow for increase in section and to release internal pressure due to thermal expansion of the insulating compound.

Oven (Electric). An oven for cooking purposes, etc., heated electrically by resistance heating elements embedded in the walls or otherwise arranged.

Overall Efficiency. The efficiency of generating plant, etc., taking into account all thermal, mechanical, and electrical losses.

Overall Equivalent (of a Telephone Circuit). The actual attenuation as measured between terminals of a telephone circuit containing a repeater.

Overcommutation. The introduction of too great an auxiliary e.m.f. into a coil, by commutating poles, etc., during short circuit by the brushes, causing a back e.m.f. which may re-introduce sparking. See FORCED COMMUTATION.

Overcompensated Meter. An induction meter reading high with a

lagging and low with a leading current, owing to too great *Phase Compensation*.

Overcompounding. The provision of sufficient series turns in a compound wound generator to cause a rise of voltage as the load increases, e.g. to compensate for feeder drop; or in a motor to cause a drop in speed as the load increases.

Over-Current Circuit-Breaker, Relay, etc. See OVERLOAD CIRCUIT-BREAKER, etc.

Over-excited Synchronous Motor. A synchronous motor in which the excitation is sufficiently high to cause an advance of the current in phase relatively to the voltage; used for the improvement of the power-factor of a circuit.

Overhead Conductor. A bare or covered wire, cable, or other conductor supported on poles or otherwise some yards clear of the ground.

Overhead Contact Line. A bare wire, etc., stretched over a railway or tramway track, from which current is taken by a contact device (*Trolley* or *Collector*) on the train or car. See TROLLEY WIRE, CATENARY SUSPENSION, etc.

Overhead Line. A circuit for transmission of power, signals, etc., supported on poles or otherwise some yards clear of the ground, as opposed to an underground cable.

Overhead System. The system of electric traction in which current is collected by the cars, etc., from an overhead line. Cf. CONDUIT SYSTEM, SURFACE CONTACT SYSTEM, THIRD RAIL SYSTEM, etc.

Overhead Wire. See OVERHEAD CONDUCTOR.

Overhearing. Interference between side and superimposed circuits in superimposed telephone working, causing overhearing of other conversations. Cf. CROSS-TALK.

Overhung Type Alternator. An alternator with external revolving field magnets carried by a flywheel alongside the fixed armature.

Overlap. A term sometimes used in connection with wireless receiving

sets for the extent to which a control dial, etc., has to be turned back from the point where its forward movement has just caused self-oscillation to a point where this just ceases without any other measures being taken.

Overlap Test. A test for fault localising purposes, in which the resistance from cable to earth is measured from each end, while the other end is free.

Overlap Test, Earth. See EARTH OVERLAP TEST.

Overload. A load greater than that which a machine or apparatus is designed to deal with under specified conditions.

Overload Capacity. The extent of overload which a machine, etc., is capable of withstanding, without undue heating, sparking, etc.

Overload Circuit-Breaker. A *Circuit-Breaker* arranged with trip gear so that it is automatically opened when a certain overload is reached.

Overload Relay. A *Relay* arranged to operate a tripping circuit when the current in the main circuit exceeds a certain overload value.

Overload Release. A device which causes a motor starter to fly back to the off position if the current exceeds a certain overload value; usually in the form of a series magnet which closes contacts, short circuiting the shunt *Holding-On Coil* of the *No-Voltage Release*.

Overmodulation (in Wireless Telephony). Excessive amplitude of the modulations in proportion to that of the carrier-wave, apt to produce *Blasting* in receiving apparatus.

Overrunning (of Incandescent Lamps). Running incandescent lamps at a voltage higher than that for which they are designed, causing an excessive filament temperature which, although increasing the light and improving the efficiency, leads to the rapid destruction of the filament and blackening of the bulb. A similar effect is produced when one or more turns of the

filament are accidentally short-circuited, as by a piece of broken filament falling across them.

Overshooting (of Incandescent Lamps). The increased current taken by a metal filament lamp momentarily after switching on before the filament has reached its full temperature, due to the resistance being lower cold than hot. (The contrary is the case with carbon filament lamps, the resistance of which is markedly lower when hot; so that the candle power takes an appreciable time to build up.)

Overtyping Dynamo or Generator. A *Bipolar* dynamo in which the armature is situated above the *Yoke*. Cf. *Undertyping Dynamo*.

Over-Voltage. (1) A voltage in a circuit which has risen above its normal value due to some temporary or accidental cause. (2) In electrochemistry: the voltage in excess of that theoretically required which is necessary with certain electrodes for the detachment of ions.

Over-Voltage Circuit-Breaker, Relay, etc. A *Circuit-Breaker, Relay*, etc., which comes into action and causes the breaking of the circuit when the voltage exceeds a predetermined value.

Over-Voltage Protective Device. A device for avoiding ill effects of sudden voltage rises, transients, or surges. See ARRESTER.

Over-Voltage Suppressor. See ARRESTER.

Oxford System. A system of distribution formerly used in which direct current was generated at a fairly high pressure and transmitted to substations, where single-armature double-commutator converters transformed it down to a low voltage for distribution.

Oxidation, Anode. See ANODE OXIDATION.

Oxide Coated Filament. A filament for a thermionic valve coated with oxides of the alkaline earth metals to improve the emission obtainable

at moderate temperatures; now largely superseded by *Thoriated Filaments*.

Oyster Fitting. A *Bulkhead Fitting* arranged to give light on both sides of the bulkhead.

Ozoniser. An apparatus in which ozone is produced for disinfection

or other purposes, by passing air by means of electrically driven fans between electrodes across which a *Silent Discharge* of electricity is caused to take place; used in conjunction with ventilating plant, etc., and for water purification, etc.

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"P." Symbol for *Power*.

Pacinotti Ring The form of *Ring Armature* used by Pacinotti in 1878 in his early dynamo. Differing from the *Gramme Ring* in that the windings were recessed in slots in the ring-shaped core.

Packing (of a Microphone). The setting of the carbon granules into tightly packed groups, which do not easily respond to the vibrations of the diaphragm, but can be freed by tapping the instrument gently.

Page Effect. The audible click heard when a bar of iron is magnetised or demagnetised.

Pairs. Large telephone cables are made up of pairs of wires each belonging to one circuit, twisted together with the necessary insulation between them. Thus a cable of 100 pairs contains wires for 100 metallic circuits.

Pallophotophone. A form of *Photophone* which has been used instead of a microphone in wireless telephony, employing a *Photo-electric Cell*.

Pancake Coil. Any flat type of coil, such as a flat *Former-Wound Coil*, as used in the early rotating armature alternators; flat, separately insulated, coils used in building up the windings of some forms of transformers, or flat forms of inductance coils used in wireless receiving sets.

Panchronous Alternator. An alternator in which the revolving field is excited from the bus-bars or through transformers connected thereto, through a commutator so that the field will rotate at the correct speed relatively to the armature, independently of the exact speed at which the machine is driven, e.g. **BLEYLAND ALTERNATOR**.

Panel (of a Switchboard). Originally the actual slab of slate, marble,

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etc., upon which one section of the switchgear, instruments, etc., is mounted, but later coming to mean one of the groups of switchgear into which the board is divided, independently of whether it is supported on a flat panel or in framework of another kind.

Panel: Bar-Coupling, Board of Trade, Control, Display, Feeder, Fuse, Generator, Meter, and Total Output. See **BAR-COUPLING PANEL**, **BOARD OF TRADE PANEL**, etc.

Panel Automatic Telephone System.

A *Rotary* automatic telephone system in use in the United States employing banks of multiple contacts arranged on flat upright panels over which the mechanically driven contact brushes move vertically; other features are the employment of a *Call Indicator* and a system of *Reversive Control*. See also **SENDER AND SEQUENCE SWITCH**.

Panel Heating. *Electric Heating* of interiors by radiation from flat heaters of considerable surface at a moderate temperature (80-100° F.) embedded in the plaster of the walls or ceilings, or at a higher temperature in panels resembling tiles forming the actual surface or mounted clear of the walls.

Panel Switch. See **FLUSH SWITCH**.

Panel Switchboard. A switchboard in which the switchgear is mounted on flat panels of insulating material such as slate or marble.

Pantograph Collector. A form of collector for electric locomotives, cars, etc., used particularly for high speeds, high voltages, and lines with *Catenary Suspension*, in which a horizontal contact bar is supported by a pair of jointed parallelogram-shaped frames, and is pressed upwards into contact with the line wire by springs or compressed air.

Paper, Pole Finding. See **POLE FINDING PAPER**.

Paper-Core Cables. Multicores cables for telephone circuits in which paper, wound fairly close round the wires, forms the principal insulation. Cf. AIR-SPACE CABLE.

Paper-Insulated Cables. Cables in which the conducting core is covered with layers of paper wound on tightly in a special machine, and afterwards impregnated with substances of a resinous or bituminous nature. Such cables are almost invariably covered with a lead sheathing to prevent access of moisture, and are sometimes provided with a further armouring of steel wire or tape with intermediate layers of fibrous material. Paper cables of this kind are largely used for power and lighting circuits up to high voltages. See also AIR SPACE, PAPER-CORE, and DRY-CORE (Telephone) CABLES.

Paragutta. An insulating material for submarine telephone cables composed of gutta serena and deproteinised rubber with a small quantity of wax.

Parallel Connection. Lamps, cells, or other apparatus or parts of circuits of any kind are said to be connected "in parallel" when the respective terminals of the same polarity are connected together so that the current divides between them. (Also called MULTIPLE ARC.) Cf. SERIES and MULTIPLE SERIES.

Parallel Distribution. The most usual system of distribution, in which all the lamps, motors, or other consuming apparatus are connected in parallel across the mains. Cf. SERIES DISTRIBUTION.

Parallel Distributor. In trolley systems, a cable running parallel to a section of the contact line, connected to it at intervals, and itself connected to a feeder.

Parallel Feeder. A feeder forming an alternative path of current to a point. (Also called *Duplicate Feeder* or *Multiple Feeder*.)

Parallel Notches or Positions (of a Controller). The positions of a *Series-Parallel* traction Controller where the motors are in parallel. Cf. SERIES NOTCHES, and see RESISTANCE NOTCHES and RUNNING NOTCHES.

Parallel Running of Alternators.

Before an alternator of the ordinary type can be connected to the generator bus-bars of a station in parallel with others already supplying current thereto it is necessary to bring the incoming alternator into exact synchronism with those already running, that is, in step as regards phase and at the same frequency. Special instruments are employed to see when these conditions are reached and the switch can safely be closed. If paralleled at the wrong time, excessive circulating currents will flow between the machines. See SYNCHROSCOPE.

Parallel Series. See MULTIPLE SERIES.

Parallel Slots. Slots, in an armature core, with parallel sides. Cf. RADIAL SLOTS and TAPER SLOTS.

Paralleling Apparatus. The whole of the switchgear and instruments required for the paralleling of alternators.

Paralleling Switch. A switch used to put an alternator in parallel with others when synchronism has been attained, e.g. that connecting the synchronising bars with the main bus-bars.

Parallels, Magnetic. See MAGNETIC PARALLELS.

Paramagnetic. Substances are said to be "Paramagnetic" when their *Permeability* is constant and greater than that of a vacuum. Originally the term included the strongly magnetic or *Ferromagnetic* substances like iron, nickel, and cobalt, but it is now commonly limited to substances of only slightly greater permeability than air, such as the rare metal erbium, which do not exhibit hysteresis effects. See CURIE'S LAW, and cf. DIAMAGNETIC.

Paramagnetism. The feeble magnetic properties shown by *Paramagnetic* substances. Cf. DIAMAGNETISM and FERROMAGNETISM.

Parasitic Currents. A name sometimes used for *Eddy Currents*.

Parasitic Losses. Losses in electrical machinery due to eddy-currents, including those in metallic parts other than those intended for use

as conductors, e.g. shafts, end shields, etc.

Parcel Plating. Electroplating only those portions of objects left uncovered by a non-conducting varnish.

Parliamentary Candle. See STANDARD SPERM CANDLE.

Parson's and Law's Leakage Method (of Compounding Alternators). A system of alternator excitation in which a higher voltage is produced by the exciter as the load rises, owing to the presence of a winding, connected through transformers to the main circuit, on a magnetic shunt or leakage path across the exciter poles, which opposes the leakage flux and therefore strengthens the main flux of the exciter when the load is high. The action depends on the fact that when iron is nearly saturated the current waves reinforcing the magnetism have little effect, whereas those of opposite sign, tending to diminish the flux, have considerable effect.

Partial Earth. A fault consisting of a connection to earth of appreciable resistance.

Parting of Metals, Electrolytic. See ELECTROLYTIC PARTING OF METALS.

Partly Closed Slot. A form of slot used in alternators, induction motors, etc., in which the top is nearly closed in, leaving only a narrow entrance, for securing good flux distribution. The winding has to be threaded in from the ends of the slots or inserted wire by wire through the narrow opening.

Partridge Safety Device. An appliance consisting of a series of metal discs separated by thin mica discs mounted in a suitable holder so that it can be plugged into spring contacts; for putting a transformer winding, etc., to earth, as soon as an abnormal voltage is produced owing to a fault, by the breakdown of the insulation of the mica discs.

Party Line. A telephone line serving a number of subscribers whose instruments are connected in parallel to it. Special arrangements are adopted for ringing up the individual stations on such a line.

See references under PARTY LINE RINGING.

Party Line Ringing. Ringing arrangements whereby it can be distinguished which of several subscribers connected to a single party line is being called.

Party Line Ringing : Code, Harmonic, and Selective. See CODE RINGING, HARMONIC RINGING, etc.

Party Line Ringing Key. A key on a telephone exchange switchboard which gives automatically the series of current impulses required to call a particular subscriber on a party line. See references under PARTY LINE RINGING.

Paschen's Law. The law regarding length of spark in gases, according to which the potential difference required is constant if the product of the gas pressure and maximum spark length is kept constant.

Passive Electrode (in Electrical Precipitation). The earthed electrode upon which the particles are deposited. (Also called the *Collecting Electrode*.) Cf. ACTIVE ELECTRODE.

Passive Quadripole. See QUADRIPOLE.

Paste. The active material, consisting of a paste of lead oxides, in accumulator plates of the "pasted" type.

Paste Joint. A joint made between a lamp filament and the leading in wires by covering with a paste, which is afterwards carbonised.

Pasted Filament. A metal filament for incandescent lamps, prepared by squirting through a die a paste composed of powdered tungsten or other metal, in conjunction with a suitable binding material. This is afterwards removed by heat treatment, which further consolidates the filament.

Pasted Plate. An accumulator plate in which the active material (lead oxides) is contained, in the form of a paste, in recesses in a lead grid forming the body of the plate. Cf. FORMED PLATE.

Pauling Furnace. An arc furnace for fixation of nitrogen. The earlier form was equipped with tubular iron electrodes arranged in V form, up which the arc rises, assisted by

an air blast; in the later form horn-shaped water-cooled aluminium electrodes are used.

P.D. Abbreviation for *Potential Difference*.

Pea Lamp. An incandescent lamp with a bulb about the size of a pea, as used in pocket flash lamps, etc.

Peak. The point where a load curve, wave-form curve, etc., reaches a maximum. See **LIGHTING PEAK** and **POWER PEAK**.

Peak Factor. The ratio of the *Peak Value* to the *R.M.S. Value*, having a value of $\sqrt{2}$ for pure sine wave-forms.

Peak Load. The magnitude of the load on a generating station or plant at the time of the day when it is a maximum, e.g. in a lighting station, just after dark.

Peak Meter. An additional meter started automatically when the demand exceeds a certain value in systems where a higher rate is charged for peak-load units.

Peak Value (of Alternating Currents, Voltages, etc.). The value at the extreme crest or peak of the wave.

Peak Voltage. The maximum or crest value of an alternating voltage.

Peak Voltmeter. See **CREST VOLT-METER**.

Peak Voltmeter, Neon Tube. See **NEON TUBE PEAK VOLT-METER**.

Peaked Wave-Form. A wave-form curve of alternating current, e.m.f., etc., the maxima of which are more pointed than those of a true *Sine Curve*. Cf. **FLAT-TOPPED WAVE-FORM**.

Pear Push. See **PENDANT PUSH**.

Pear Switch. See **PENDANT SWITCH**.

Pearl (Incandescent) **Lamp.** See **INSIDE FROSTED LAMP**.

Peg. A term used in the earlier days of telephony, particularly in the Post Office, for *Plug*.

Peltier Coefficient. The energy absorbed or given out per second when unit current is caused by an external e.m.f. to flow through a junction of dissimilar metals; numerically equal to the potential difference at the junction in (electromagnetic) C.G.S. units, and varying for different temperatures. See **PELTIER EFFECT**.

Peltier Effect. The raising or lowering of the temperature of a contact between two dissimilar metals by passing a current through it by means of an external e.m.f., in the contrary or the same direction, respectively, as their own thermoelectric e.m.f. when heated, owing to the evolution or absorption of energy.

Pen (Electric). A pen introduced originally by Edison in which a point is caused to reciprocate backwards and forwards in the holder by means of a small motor carried on the pen and fed by a flexible cord, so that the writing is made by perforations in the paper, which can afterwards be used as a stencil.

Pendant. An electric light fitting for suspension from a ceiling, etc., by its own flexible cord or otherwise.

Pendant, Rise and Fall. See **RISE AND FALL PENDANT**.

Pendant Push. A *Push Button* arranged for attachment to a flexible cord.

Pendant Socket Outlet. A *Socket Outlet* arranged in attachment to a flexible cord.

Pendant Switch. A switch for attachment to a flexible cord. (Also called *Suspension Switch*, *Pressel Switch*, and *Pear Switch*.)

Pendulum (Electric). A pendulum which is caused to continue swinging indefinitely by being attracted by an electromagnet for a moment during each swing by the agency of a contact attached to the pendulum itself.

Penetrating Radiation. See **COSMIC RAYS**.

Penetration of Current. The distance from the surface of a conductor into its interior, beyond which an alternating current of high frequency does not penetrate appreciably; depending on the frequency and the magnetic permeability of the material. In the case of iron, for example, at a frequency of 100 cycles, current does not penetrate to more than a depth of about 2 mm. and oscillations of frequency of the order of millions are limited to a depth of less than 1/100 mm. See **SKIN EFFECT**.

Penetrometer. An instrument for gauging the *Hardness* (penetrating power) of "X" Rays.

Pentagrid Converter. A *Thermionic Valve* provided with five grids, for use in *Superheterodyne Receivers* to effect complete conversion from high to intermediate frequency in one valve combining the functions of local oscillator, detector, and amplifier.

Pentane Lamp. A standard lamp burning pentane vapour in an argand burner and designed to give 10 British candle power under specified conditions; used more for gas testing than for photometry of electric lamps.

Pentatron. A five electrode valve with two plates, two grids, and one filament, rendering the *Push-Pull* system of amplification possible with a single valve.

Pentode. A *Thermionic Valve* with five electrodes, e.g. with a filament, plate, and three grids acting as *Control Grid*, *Screen Grid*, and an additional low potential *Anti-Secondary Grid* eliminating the negative resistance portion of the characteristic; used as a power amplifier of high amplification factor, especially where there is only one stage of low frequency amplification. See also *PENTATRON*.

Pentode, Screened. See *SCREENED PENTODE*.

Pentode Multiplex. See *MOUSE MULTIPLEX SYSTEM*.

Pentone. Trade name of one form of pentode.

Percentage Conductivity. The ratio (expressed as a percentage) of the conductivity of a given sample of copper compared to the standard conductivity of copper.

Percentage Coupling. A *Coupling Factor* expressed as a percentage.

Percussive Rock Drill. See *REPRODUCING ROCK DRILL*.

Perfect Dielectric. A substance entirely without free ions or electrons, and therefore entirely non-conducting, as the application of an e.m.f. cannot effect transfer of electrons but only elastic displacement thereof.

Perfect Magnetic Circuit. An expression sometimes used for a magnetic

circuit consisting entirely of *Ferro-magnetic* material. Cf. *IMPERFECT MAGNETIC CIRCUIT*.

Perfect Rectifier. A rectifier which allows of no flow of current in the reverse direction.

Perforator, Receiving. See *RECEIVING PERFORATOR*.

Peridyne Reception. A system of wireless reception employing an inductance enclosed in a metal case with a movable screen which serves as a fine adjustment to the effective inductance of the coil.

Perikon Detector. A detector of the rectifier class, consisting usually of a contact between a point of copper pyrites (bornite), and a mass of crystalline zinc oxide (zincite).

Period. Usually used to signify the time occupied by one complete *Cycle*, i.e. including two waves in opposite directions, but occasionally used in older works for half a cycle or one wave only.

Periodic Time (of an Alternator). The period of free swing or oscillation in speed of an alternator running in parallel with others and under the influence of a disturbing torque and a synchronising torque. Symbol: *T*.

Periodicity. The number of periods of an alternating current, voltage, etc., making up one second. See also *FREQUENCY*.

Peripheral Dispersion. The magnetic leakage in a machine along the air gap from the periphery of the stator. Also called *Main Dispersion*.

Perkin's Phenomenon. A decrease in the conductivity of a rod of graphite which is found to take place when a negative charge is imparted to it.

Permalloy. An alloy containing 78.5 per cent of nickel and 21.5 per cent of iron which, after subjection to certain heat treatment, has a much greater permeability (about thirty times) and much lower hysteresis than soft iron at low magnetising forces; used in the *Continuous Loading* of submarine cables, and extending the possible use of them very considerably.

Permanent Crystal Detector. A crystal detector in which contact is made between two crystals held together

by a light spring; when once set comparatively little further adjustment is necessary.

Permanent Magnet. A magnet made of specially hardened steel, such as tungsten steel, or alloy of iron, nickel, aluminium and cobalt, etc., which retains the greater part of its magnetisation, after the magnetising force is removed, for an indefinite period.

Permanent Magnet Instruments. Instruments, such as those of the moving coil type, in which the magnetic field is provided by permanent magnets; used for direct current only.

Permanent Magnet Moving-Coil Loud Speaker. A *Moving-Coil Loud Speaker* in which the constant field is produced by a permanent magnet system.

Permanent Magnetism. That part of the magnetisation of a permanent magnet which remains constant for an extended period after the subpermanent magnetism has been removed by a special ageing treatment or by lapse of time.

Permeability. The ratio of the *Flux Density* (B) in a piece of magnetic material to the *Magnetising Force* (H) producing it; of widely varying value for different values of the flux density, even for the same material. The permeability of air and nonmagnetic materials is unity, and of diamagnetic materials, negative. Cf. SUSCEPTIBILITY. Symbol, μ .

Permeability, Time Decrease of. See TIME DECREASE OF PERMEABILITY.

Permeability Bridge. An instrument for magnetic testing in which magnetic fluxes in different branches of a divided magnetic circuit are balanced against each other.

Permeability Bridge: Ewing and Holden. See EWING PERMEABILITY BRIDGE and HOLDEN PERMEABILITY BRIDGE.

Permeability Curve. A magnetisation curve showing the relation between *Flux Density* and *Magnetising Force*, from which the permeability at any value of the former or latter can be ascertained, for a particular material.

Permeability Tuning. Tuning of the high-frequency circuits of wireless receivers by moving the core of the coils to change their inductance, without the employment of variable condensers. This is rendered possible by the use of *Dust Cores*.

Permeameter. The name by which some of the various instruments for measuring the permeability of samples of magnetic material are known.

Permeameter: Drysdale, Esterline, Koepsal, Mercury Helix, Thompson, and Traction. See DRYSDALE PERMEAMETER, ESTERLINE PERMEAMETER, etc.

Permeance. The reciprocal of *Reluctance*; i.e. permeability multiplied by cross-section, divided by length.

Perminvar. An alloy of iron, nickel, and cobalt, possessing practically constant permeability over a considerable range of the magnetisation curve with low hysteresis.

Permissible Overload. The degree of overload which can be borne by a machine or apparatus under specified conditions.

Permittal. A non-inflammable non-hygroscopic liquid of high permittivity used instead of oil for transformers.

Permittance. A name sometimes used for capacity under the same conditions as described under *Permittivity*.

Permittivity. The ratio of the electric displacement produced in a particular medium to the electric force producing it as compared with the ratio for a vacuum. Symbol: κ (Greek kappa). Also called *Dielectric Constant*, *Dielectric Co-efficient*, or *Inductivity*.

Permutator. A machine for conversion of alternating current into direct current, either with a system of revolving brushes driven by a synchronous motor working over a commutator connected to a fixed winding, as in the Roug -Faget permutator, or of the nature of a *Rectifier* with a synchronously driven two-part commutator with auxiliary segments connected toappings on a choking coil by which a certain amount of voltage

regulation can be obtained, as in the Auvert Ferrand machine.

Persistence. A name sometimes given to the *Time Constant* of an inductive circuit.

Petersen Coil. A reactance placed between the earth and a neutral point on an otherwise unearthed three-phase system, with a view to compensating the capacitance of the lines to earth through which a current is liable to flow or the occurrence of an earth on one phase. Also called *Arc Suppressor* because its function is to render the formation of an arc following a flash-over impossible.

Petoscope. An apparatus for detecting by means of photoelectric cells movement of persons or objects against a background by alteration of the balance in the light falling upon two complementary chequered screens, upon which images of the objects in question are thrown by lenses.

Petrol-Electric Car. See PETROL-ELECTRIC TRACTION.

Petrol-Electric Generating Set. A set consisting of a *Generator* and a petrol engine which drives it. Used for independent lighting and portable generating plant, etc.

Petrol-Electric Traction. A system of road or railway traction in which the motive power is a petrol engine, or engines, carried on the vehicle and the power is transmitted electrically to the driving shaft or axle, either always or only when the higher torque ratios are required. By this means, a variable torque ratio can be obtained without changes of mechanical gear.

Petrol-Electric Transmission. The transmission of power electrically from a petrol engine to the driving shaft of an automobile or rail car.

Petticoat (of an Insulator). An umbrella shaped shield forming part of the usual type of porcelain insulator which is mounted on a central pin, provided to increase the length of leakage surface which can be left dry.

Petticoat Insulator. A porcelain or other line insulator provided with one or more (often three) *Petticoats*. Cf. SUSPENSION INSULATOR.

Phanotron. A metal-cased *Mercury Vapour Rectifier* with an independently heated cathode to supply the electron emission at starting.

Phantom Aerial. See ARTIFICIAL AERIAL.

Phantom Circuit. The equivalent of an additional telephone circuit formed by the use, in parallel, of pairs of existing wires forming ordinary insulated circuits. The instruments belonging to the lines so used are connected to form a bridge accurately balanced so that the superimposed current of the "phantom" circuit does not affect them. Cf. PHYSICAL CIRCUIT.

Phantom Circuit: Double, Quadruple, and Octuple. See DOUBLE PHANTOM CIRCUIT, QUADRUPLE PHANTOM CIRCUIT, etc.

Phantophone. A telephone system for speaking over lines used simultaneously for telegraphy, in which the receivers and transmitters are connected to the line through transformers with condensers in series with them, so that they are not affected by the telegraph signals.

Phase. (1) The position of a particular point in the cycle of an alternating current e.m.f., etc., expressed as an angle (the whole cycle being taken as 360°), i.e. the angle made by the vector representing the variable quantity, in moving from the zero position to the position corresponding to the moment in the cycle under consideration. (2) Used in practice also to signify one of different portions or *Branches* of a circuit in which currents are flowing which reach different phase angles at the same time. See SINGLE-PHASE, TWO-PHASE, THREE-PHASE, POLYPHASE, etc.

Phase, Lagging, Leading, and Reversal of. See LAGGING PHASE, LEADING PHASE, etc.

Phase Advancer. An apparatus used to improve power-factor, e.g. in conjunction with large induction motors by supplying a current component to the rotor of a frequency corresponding to the slip; thus obviating the necessity of supplying a magnetising com-

ponent to the stator. See also **WALKER PHASE ADVANCER**, **KAPP VIBRATOR**, and **RECUPERATOR**.

Phase Advancer: **Expedor**, **Rotary**, **Scherbius**, **Slip-Ring**, **Susceptor**, and **Vibratory**. See **EXPEDOR PHASE ADVANCER**, **ROTARY PHASE ADVANCER**, etc.

Phase Angle. The angle between the vector representing any periodic function such as an alternating current and the vector giving rise to it. In instrument transformers, the angle between the primary and reversed secondary vectors.

Phase-Balance Relay. A relay for the protection of polyphase motors, rotary converters, etc., from effects of excessive unbalance or reversal of phases, arranged to respond to the component of negative phase sequence.

Phase Band. The section of the conductors in one pole pitch of a polyphase winding belonging to one phase.

Phase Changer. An apparatus for converting currents to a different number of phases at the same frequency. (Employed on some electric locomotives to enable three-phase induction motors to be run from a single-phase overhead contact line.) Also called **Phase Changer** and **Rotary Phase Converter**.

Phase Compensation. (1) The measures taken in an alternating-current meter of the induction type to avoid error on inductive load due to the difference in phase between the current and e.m.f., by an arrangement of inductances and resistances in the pressure circuit, by a short-circuited secondary coil on the pressure coil, or by adjustments of the inductance of sections of the current coils. (2) See **PHASE COMPENSATOR**.

Phase Compensator or Equaliser. A combination of inductance, capacitance, and resistance designed to compensate for the variation of phase with frequency on a line.

Phase Converter. See **PHASE CHANGER**.

Phase Correction. The maintenance of synchronism in machine telegraph systems in the correct phase relationship by automatic sending of correcting impulses.

Phase Creep. A progressive error in phase in the running of machine telegraph apparatus, etc., slightly out of synchronism.

Phase Difference. The difference between the phase angles of alternating e.m.f.'s., currents, etc., in the same or different circuits. Usual symbol ϕ .

Phase Displacement. A change in the phase angle of an alternating current, by such a means as the introduction of inductance or capacitance into the circuit.

Phase Distortion. Distortion of received signals due to unequal phase-shifting of components of different frequencies.

Phase Error (of Instrument Transformers). The error introduced in the reading of instruments of the wattmeter type working through current and potential transformers, due to the secondary current not being exactly 180° out of phase with the primary at all loads. See also **RATIO ERROR**.

Phase Factor. The vector quantity by which the maximum impressed e.m.f. must be multiplied, together with the *Attenuation Factor*, to obtain the e.m.f. at any point in a wave being propagated along a conductor. [According to the usual notation, in the equation $V = Ee^{-\alpha x}(\cos \beta x - j \sin \beta x)$, $e^{-\alpha x}$ is the attenuation factor and $(\cos \beta x - j \sin \beta x)$ in the phase factor.]

Phase Fading. Fading of wireless signals due to difference in phase of direct and indirect received waves. Cf. **INTENSITY FADING**.

Phase Indicator and Phase Meter. See **POWER-FACTOR INDICATOR**.

Phase Isolated Switchgear. See **ISOLATED PHASE SWITCHGEAR**.

Phase Modifier. An apparatus, such as a *Synchronous Condenser* or a *Synchronous Reactor*, which can advance or retard the phase of an alternating current with respect to the voltage as desired for regulation of power factor, line drop, etc.

Phase Relationship (in Synchronous Telegraph Systems). The degree of divergence from synchronism between the distributor brushes at the two stations.

Phase Sequence. See SUCCESSION OF PHASES.

Phase Sequence Indicator. An instrument for showing the order in which the voltages reach their maxima in the various phases in a polyphase system.

Phase Shifting Transformer. A transformer for obtaining currents for such purposes as alternating current potentiometer working at any desired phase difference with the main current. Two primaries are used carrying currents 90° in phase apart, and a secondary is provided which can be rotated into any angular position with respect to them.

Phase Splitter. A name given to a machine for producing a three-phase voltage from a single-phase supply.

Phase Splitting Device. An arrangement for obtaining currents from the same source in two branches of a circuit with considerable phase difference between them; used for obtaining a rotary field for starting single-phase induction motors, and in induction motors; usually consisting of the introduction of inductance or capacitance in one branch, or both in opposite branches of the circuit.

Phase Swinging. Alternate lagging and leading of phase in alternating current machinery running in parallel, due to oscillations of speed above and below the normal.

Phase Transformer. (1) A transformer for giving a secondary voltage differing in phase from the primary current. (2) A transformer for converting to a different number of phases.

Phase Voltage. An expression somewhat loosely used for *Line Voltage* and *Star Voltage*, but generally for the latter.

Phases, Succession of. See SUCCESSION OF PHASES.

Phasing. A term used in *Television* for the adjustment required to bring the formation of the image into phase with the scanning of the object.

Phasing Coil. See FRANKLIN AERIAL.

Phi (ϕ) Symbol for *Magnetic Flux*.
(ϕ) Symbol for *Phase Difference*.

Phasing-in. See SYNCHRONISING.

Pherope. See *Telephoto*.

Phon. The name sometimes used for the unit used in sound measurement equivalent to the *Decibel*.

Phone. Popular abbreviation of *Telephone*.

Phonic Capacitance Meter. An apparatus in which the audio-frequency of oscillations produced by the periodic discharge of a condenser in parallel with a neon tube is compared with that of a similar circuit containing a standard variable condenser which is brought to a value giving the same frequency as revealed by the note produced in a telephone.

Phonic Control. The control of a direct current motor required to run at constant speed by a rheostat which automatically varies the controlling resistance according to the difference in speed between the main motor and a *Phonic Wheel* forming part of the controlling apparatus.

Phonic Drum Motor or Phonic Wheel. A simple form of constant speed motor used for driving multiplex and printing telegraph apparatus, etc., in which iron projections on an unwound iron armature are attracted by field magnets energised periodically by current impulses controlled by a vibrating contact maker consisting of a tuning fork or tuned reed.

Phono-Electric Wire. The trade name of a trolley wire made of a special alloy, harder and more durable than copper but of lower conductivity.

Phono-Film. See SOUND FILM.

Phonographic Recorder. See DICTAPHONE RECEPTION.

Phonometer. An apparatus for measuring or comparing sounds.

Phonometer, Alternation. See ALTERNATION PHONOMETER.

Phonoplex (Telegraph) System. A multiplex system of telegraphy in which a number of signals can be sent over the same line simultaneously by utilising interrupted currents of different frequencies for each signal, to each of which a particular receiver is tuned to respond.

Phonopore. A form of telephone receiver suitable for use on lines which are also used for telegraph working, in which the speaking current flows into a condenser of very low capacitance formed by two wires placed side by side.

Phonoscope. An instrument for recording wave forms of audio-frequency. It is claimed that deaf persons can be trained to interpret such records of speech and music.

Phonotelemetry. See RADIO-ACOUSTIC POSITION FINDING and ECHO DEPTH SOUNDING.

Phonovision. The use of a gramophone record made from the sounds produced in a telephone by the variations of current from a television transmitter for subsequent reproduction of the original image by an apparatus resembling a gramophone "pick-up" and a television receiver.

Phoroscope. An early form of experimental television apparatus (L. Weiller, 1889) employing a series of synchronously revolving mirrors and a vibratory flame receiver.

Phosphorescence. The emission by a body as visible radiation of energy absorbed from radiation which has previously fallen upon it. Cf. FLUORESCENCE.

Phosphorescent Glow. The glow emitted by certain bodies such as the glass of a *Crookes Tube* when cathode rays fall upon them. The effect is particularly marked with uranium glass and solutions of quinine, etc., and is perhaps more correctly described as *Fluorescence*.

Phot. A unit of illumination equal to 1 *Lumen* per square centimetre. (One foot-candle = 1.0764 milli-phot.) Cf. LUX.

Photic Radiation. A term sometimes used for *Visible Radiation*. Cf. ULTRAPHOTIC RADIATION.

Photon. A gas-filled two-electrode valve tube giving a strongly actinic glow, which can be varied by superposing telephone modulations upon the current through it, so that it can be used in *Sound Film* apparatus.

Photocell. See PHOTO-ELECTRIC CELL.

Photo-Chemical Cell. See PHOTO-VOLTAIC CELL (Electrolytic type).

Photo-Conductive Cell. A *Photo-Electric Cell* of the type in which the internal resistance varies according to the light falling upon it, e.g. the *Selenium Cell*. See PHOTO-CONDUCTIVITY.

Photo-Conductivity. See PHOTOELECTRIC CONDUCTIVITY.

Photo-Electric Cell. A general term for any kind of *Light Sensitive Cell* including *Photo-conductive*, *Photo-emissive*, and *Photo-voltaic cells*. Such cells are used extensively in photometry, colour matching, sound film apparatus, television, burglar alarms and in the optical control of a variety of apparatus.

Photo-Electric Cell: **Hard, Rectifier,** and **Soft.** See HARD PHOTO-ELECTRIC CELL and RECTIFIER PHOTO-ELECTRIC CELL.

Photo-Electric Conductivity. The property of certain crystals, especially those of high refractive index, whereby they assume increased conductivity when light falls on them, due to internal movement of electrons similar to the external movement in *Photo-Electric cells* of the emissive type. See SELENIUM CELL.

Photo-Electric Cryptometer. An instrument for measuring the "hiding" power of paints by observing the difference in the light reflected by a film of paint of known thickness with a black and white backing.

Photo-Electric Effect. Any change in electrical properties produced by the incidence of light on a body.

Photo-Electric Photometer. A photometer depending upon the properties of the *Photo-Electric Cell* for light measurement.

Photo-Electricity. The omission of electrons from certain surfaces as a result of the incidence of radiation.

Photo-Electrolytic Cell. See PHOTO-CHEMICAL CELL.

Photo-Electrons. Electrons omitted as described under PHOTO-ELECTRICITY.

Photo-Emissive Cell. The type of *Photo-Electric Cell* which depends upon *Photo-emissivity* and becomes conductive when exposed to light owing to the electrons given

off by the cathode. Cf. PHOTO-CONDUCTIVE CELL.

Photo-Emissivity. The property (made use of in some *Photo-Electric Cells*) possessed by certain materials, such as potassium, sodium, cesium, and rubidium, of emitting electrons when light falls on their surface.

Photogramophone. One form of apparatus for the production of *Sound Films*.

Photographic Recorder (Wireless). An apparatus for the recording of high-speed wireless messages by recording the deflections of a reflecting *Thermogalvanometer* or other instrument affected by the current impulses in the receiving circuit, photographically on a moving film.

Photography, Spark. See SPARK PHOTOGRAPHY.

Photometer. An instrument for measuring luminous intensity, illumination, etc., usually by comparison with a standard.

Photometer : Bunsen, Contrast, Dispersion, Flicker, Grease-Spot, Globe, Illumination, Integrating, Lummer-Brodhun, Photo-Electric, Ritchie, Rumford, Simmance-Abady, Spectro-, Trotter, Weber, and Wedge. See BUNSEN PHOTOMETER, CONTRAST PHOTOMETER, etc.

Photometric Integrator. That part of an *Integrating Photometer* which enables the total luminous flux to be observed by a single observation, e.g. the ULBRICHT GLOBE.

Photon. The name given to the elementary unit of radiation corresponding to Planck's Quantum of Energy. See RADIATION and QUANTUM THEORY.

Photophone. An instrument for transmitting sound or speech over short distances, by variations in a beam of light. These are produced either by a mirror attached to a diaphragm or by variations in the strength of the source of light controlled by a microphone of some kind. In the receiving apparatus, the variable beam falls upon a selenium of other light sensitive cell in series with a battery and telephone receiver and produces variations in the resist-

ance of the cell which modulate the current in the telephone receiver and reproduce the original sounds. Thermionic amplification can be used. Also sometimes called *Telephotophone*. See SOUND FILM, PHOTON, and THALOWIDE CELL and cf. PHOTOTELEPHONE.

Photophore. An instrument for examining the interior parts of the human body, fitted with a small incandescent lamp and the necessary tubes, mirrors, lenses, etc.

Photoradiogram. A reproduction of a photograph or drawing made by wireless *Phototelegraphy*.

Phototelegraphy. The telegraphic reproduction of photographs, or other "*Still Pictures*," by means of a series of signals, either in the form of variations in the current in a circuit or waves radiated from a wireless transmitting station, controlled by photo-electric cells or otherwise, according to the density of that portion of the original mounted on a revolving drum passing a certain point. These signals control the photographic effect of a beam of light falling upon a sensitive film on a synchronously revolving drum in the receiving apparatus, or otherwise cause marks to be made thereon. In the latest developments advantage is taken of the properties of recent forms of photo-electric cells, thermionic amplification, and carrier wave systems of telegraphy. See ALEXANDERSON SYSTEM, BELL SYSTEM, BELIN SYSTEM, ELBROTHOGRAPH, FULTOGRAPH, KAROLUS SYSTEM, KORN SYSTEM, and TELETHROGRAPH.

Phototelephone. An instrument on similar principles to the *Photophone* for transmission of sounds or speech over considerable distances.

Phototelephony. The transmission of sounds or speech over considerable distances by means of variations in a beam of light.

Photo-Tube. See PHOTO-ELECTRIC CELL.

Photo-Voltaic Cell. A *Photo-electric cell* of the type in which a potential difference is actually set up within the cell itself, either of the

- Electrolytic type* with two dissimilar electrodes in a liquid electrolyte or of the *Electronic type* (also known as *Rectifier Cells* or *Barrier-Layer Cells*) in which the effect of light is to cause electrons to pass from a semi-conducting layer (e.g. cuprous oxide or selenium) to an adjoining metal plate.
- Photronic Cell.** A form of *Photo-Electric Cell* used in photometry.
- Physical Circuit.** An actual metallic telephone circuit as distinguished from a *Phantom Circuit* superimposed thereon.
- Physio-Therapy.** See *ELECTRO-THERAPY*.
- Piano (Electric).** A self-playing piano in which the mechanism is driven by an electric motor.
- Picein Drop Method.** A method of testing dielectric strength of sheet materials in which uniformity of voltage distribution is obtained by applying the puncturing voltage through a small perforation in a drop of "picein" wax which has been let fall on the sheet.
- Pick-Up, Gramophone.** See *GRAMOPHONE ATTACHMENT*.
- Pickling, Anode.** See *ANODE PICKLING*.
- Picofarad.** ($\mu\mu$ F.) 10^{-12} farad. Cf. *MICROFARAD*.
- Picture Element (in Television).** The portion of the scene corresponding to the instantaneous value of the signal current.
- Picture Frequency (in Television).** The number of complete images (each consisting of several *Frames* in *Interlaced Scanning*) reproduced per second.
- Picture Strip (in Television).** See *SCANNING LINE*.
- Picture Telegraphy.** See *PHOTO-TELEGRAPHY*.
- Pidgeon Machine.** An improvement on the *Voss* and *Wimshurst Influence Machines* with a large number of embedded sectors and other special features.
- Piezo-Electric Coupler.** A *Piezo-Electric Resonator* with two pairs of electrodes by which energy can be transferred from one circuit to another at the frequency of resonance.
- Piezo-Electric Crystal.** A crystal showing the *Piezo-Electric Effect*.
- Piezo-Electric Effect.** The property of certain crystals of becoming electrified when mechanical pressure is applied in certain directions. In such crystals a *Converse Piezo-Electric* effect is produced in that on the application of an e.m.f. produces a strain.
- Piezo-Electric Frequency Stabiliser.** See *FREQUENCY STABILISER*.
- Piezo-Electric Indicator.** An indicator for internal combustion engines, etc., in which the varying voltage produced by changes of the pressure on a system of quartz crystals within the cylinder are measured by a thermionic voltmeter.
- Piezo-Electric Oscillator.** A *Piezo-Electric Resonator* used in conjunction with a thermionic valve circuit to initiate oscillations of constant frequency. Used in some forms of *Independent Drive* for ensuring constancy and accuracy of frequency in wireless transmitting stations.
- Piezo-Electric Pressure Gauge.** An apparatus used for recording pressures in gun barrels, etc., consisting of a series of quartz discs or other piezo-electric crystals suitably mounted in electrodes connected to an oscillograph which records the change in e.m.f. due to the changes in mechanical pressure usually after appropriate amplification.
- Piezo-Electric Relay.** An electrically excited *Piezo-Electric Resonator*, which when in a state of resonance produces sufficiently large e.m.f.s. to cause electrostatic attraction which closes a contact.
- Piezo-Electric Resonator.** An apparatus in which resonance is exhibited due to rapidly alternating *Piezo-Electric* and *Converse Piezo-Electric Effects* in a quartz or other crystal suitably mounted. Such resonators can be used as standards of frequency, and as *Frequency Stabilisers*.
- Piezo-Electricity.** An old-fashioned term for an electric charge produced by the *Piezo-Electric Effect*.
- Pigtail.** A short length of flexible

stranded or braided copper conductor attached to a carbon brush, to convey the current to the terminal on the brush-holder.

Pile: Dry, Galvanic and Voltaic. See DRY PILE, GALVANIC PILE, etc.

Pillar: Feeder, Section, Switch, and Switchgear. See FEEDER PILLAR, SECTION PILLAR, etc.

Pillar Type Switchgear. Switchgear in which the actuating gear and instruments forming each section, i.e. that belonging to each generator, feeder, etc., is mounted on a separate pillar.

Pilon Regulator. A vacuum regulating device for *X-Ray Tubes* consisting of auxiliary electrodes of a material which gives off a small amount of gas when a current is passed through them by temporary connection to the cathode. Cf. OSMO-REGULATOR and MERCURY AIR VALVE REGULATOR.

Pilot. See PILOT WIRE.

Pilot, Embedded. See EMBEDDED PILOT.

Pilot Brush. (1) A single brush in a set of several, set slightly in advance of the others to improve commutation by final breakage of the current with a reduced area of contact. (2) An *Exploring Brush*.

Pilot Cable. See LEADER CABLE.

Pilot Cell. One cell in a battery of accumulators from which test readings are taken to indicate the condition of the whole battery.

Pilot Controller. See MASTER CONTROLLER.

Pilot Lamp. (1) A lamp connected in parallel with some piece of apparatus, such as one of the heaters in an electric cooker, to show by lighting up when a current is flowing through the apparatus in question. (2) A signal lamp on a telephone exchange switchboard controlled by a relay so that it lights up when a subscriber connected to that part of the board is making a call.

Pilot Motor. (1) A motor employed in variable speed systems or drive with higher gear ratio than the main motor, only used at the lowest speeds. (2) A small motor

employed to actuate auxiliary apparatus such as a controller.

Pilot Relay. A relay controlling a *Pilot Lamp* on a telephone exchange switchboard.

Pilot Signal (in Telephony). Any signal by a lamp or otherwise, denoting a change in connections in one or more of a group of circuits.

Pilot Spark. See TRIGGER SPARK.

Pilot Spark Arc Rectifier. A rectifier depending upon the unilateral conductivity of an arc which extinguishes itself after every half-wave in one direction and is restarted by a pilot spark at the commencement of the next half-wave in the same direction.

Pilot Synchronizing. A method of controlling the frequency of the local oscillator in *Suppressed Carrier* and allied systems of wireless telephony by means of an auxiliary or pilot signal.

Pilot Voltmeter. A voltmeter on a central station switchboard which reads the voltage at the far end of a feeder to which it is connected by a *Pilot Wire*.

Pilot Wire. (1) An auxiliary wire, either contained in a feeder cable or running alongside of it, used for auxiliary purposes and not for the transmission of energy. (2) In telephony and telegraphy: a wire in a multiple cable used for insulation testing only. (3) An additional wire in a telegraph or telephone line employed to operate a device for varying the degree of amplification of a repeater according to changes of temperature of the line.

Pin, Insulator. See INSULATOR PIN.

Pin Type Insulator. The type of porcelain or other insulator for overhead lines which is supported by a central vertical *Pin*. Cf. SUSPENSION INSULATOR.

Pin Winding. See THREADED IN WINDING.

Pinch Effect. The peculiar constriction shown in liquid conductors carrying heavy currents, as in an electric furnace, due to the mutual attraction between parts of a conductor carrying currents in parallel directions, in

virtue of which a conductor is always tending to narrow itself when traversed by a current. The effect is so great sometimes in electric furnaces as to cause breakage of the circuit. See also **HERING FURNACE**.

Pipe-Ventilated Motor or Generator.

A totally enclosed machine provided with fittings for attachment of pipes by which a current of air for cooling can be caused to circulate within the case by a fan carried on the rotor or otherwise.

Pipless Bulb. An incandescent lamp bulb without a visible sealing off projection or "pip."

Pitch : Fractional, Polar, Pole, Slot, and Winding. See **FRACTIONAL PITCH, POLE PITCH**, etc.

Pitch Coefficient. See **PITCH FACTOR**.

Pitch Diameter (of a Cable). The diameter of a cable measured from centre to centre of the strands of the outside, or any other layer.

Pitch Factor. A factor introduced into formulæ for the e.m.f. given by a *Fractional Pitch Winding* to allow for the fact that the two sides of the coil do not lie in similar positions under adjacent poles.

Pith Ball Electrometer. An old form of *Electrometer*, in which the charge is measured by the angular position of a thread carrying a pith ball repelled by the pillar from which it is suspended.

Pith Ball Electroscop. A simple piece of apparatus consisting of two small balls made of pith, suspended by silken threads, which show the presence of a charge in a neighbouring body by flying apart, due to the mutual repulsion of the charges induced in them.

Pivot Jaw (in a Switch). A *Contact Jaw* to which a switch is pivoted, always in contact with the blade.

Plain Aerial Transmitter. A transmitter on the *Spark System* of wireless telegraphy, in which the spark gap is in series with the aerial.

Plain Condenser. See **STRAIGHT LINE CAPACITY CONDENSER**.

Plain Conductor. A conductor of one metal only. Cf. **TINNED CONDUCTOR**.

Plain Conduit. See **PLAIN STEEL CONDUIT**.

Plain Cored Carbons. Arc lamp carbons with cores not impregnated with special chemical materials. Cf. **FLAME CORED CARBONS**.

Plain Coupler. A coupler for plain (non-threaded) conduit tube.

Plain Cut-Out. See **PLAIN FUSE**.

Plain Fuse. A *Fuse* with unenclosed **FUSE LINE**.

Plain Lead-Covered Cable. *Lead-Covered Cable* with no special protection over the lead sheath.

Plain Steel Conduit. Light steel conduit tube for containing wiring, in lengths without screwed ends.

Plain Tuning Error (in Wireless Direction Finders). An error occurring when one loop is more nearly in tune with the incoming wave than the other.

Plane Polarisation. Limitation of wave motion (such as light or other electric waves) at right angles to the direction of propagation to one plane only. Cf. **CIRCULAR** and **ELLIPTIC POLARISATION**.

Planck's Constant. See **QUANTUM THEORY**.

Plant: Converting and Generating. See **CONVERTING PLANT** and **GENERATING PLANT**.

Plant Capacity. The normal full load output of the whole of the generating plant in a station, including spare plant, if any.

Plant Efficiency. The relation of the energy output of a generating station or plant to the energy contained in the fuel consumed, or the water passing through the turbines in a hydro-electric station, usually expressed as a percentage.

Planté Accumulator Cell. A lead accumulator of the class in which the plates have the active material "formed" upon them by electrochemical means by continued and repeated charging and discharging, and not applied in the form of a ready prepared paste. Cf. **FAURE ACCUMULATOR**.

Planté Plate. See **PLANTÉ ACCUMULATOR**.

Plasma. The region of low electric field in a discharge-tube, where the positive and negative electron

concentrations are equal. Cf. SHEATH (3).

Plastic Rail Bond. A *Rail Bond* formed by plastic conducting material applied between the rail itself and the fishplate, or in which a joint between a copper bond and the rail is made by a plastic conducting material.

Plate. (1) One of the electrodes of a condenser or of an accumulator. (2) The name commonly used for the anode of a *Thermionic Valve* which receives the bombardment of electrons projected from the hot cathode; more often in the form of a cylinder than a flat plate; often made of nickel and sometimes of molybdenum.

Plate(s): *Armature-Core, Ceiling, Earth, End, Faure, Field, Formed, Guard, Negative, Pasted, Plated, Positive, and Transformer.* See ARMATURE-CORE PLATE, CEILING PLATE, etc.

Plate Battery. See HIGH TENSION BATTERY.

Plate Circuit. The circuit connected to the anode or *Plate* of a *Thermionic Valve*. Cf. GRID CIRCUIT.

Plate Circuit, Tuned. See TUNED PLATE CIRCUIT.

Plate Condenser. A simple form of condenser such as one for testing the specific inductive capacity of different materials, with the electrodes formed by two parallel plates, sometimes with adjustable distance between them.

Plate Current. See ANODE CURRENT.

Plate Fuse. A fuse in which the fuse-link is a flat strip of metal.

Plate Impedance (of a *Thermionic Valve*). See INTERNAL IMPEDANCE.

Plate (Electrical) Machine. An early form of frictional electrostatic machine in which the charge is produced by friction between a pad and a revolving disc of glass, or other dielectric. Cf. CYLINDER ELECTRICAL MACHINE.

Plate Modulator. See ANODE MODULATOR.

Plate Protected Motor. A ventilated enclosed motor for use in collieries, etc., made flame-tight by arranging the intake and outlet orifices for the ventilating air so that it has to pass through narrow channels

between a number of separated parallel metal plates having the same effect as the gauze in a safety lamp.

Plate Protection. The rendering of any apparatus for collieries flame-tight by guarding all orifices after the manner of a *Plate Protected Motor*.

Plate Voltage. See ANODE VOLTAGE.

Plated Carbons. *Arc Lamp Carbons* electroplated outside with copper to improve their conductivity and to facilitate good contact with the holders.

Platinating. Electroplating with platinum. (Non-electrical deposition of platinum is called *platinising*.)

Plating: *Barrel, Bright, Chromium, Copper, Electro-Nickel, and Parcel.* See BARREL PLATING, BRIGHT PLATING, etc.

Plating Dynamo. A dynamo designed to give a heavy current at a low voltage for electroplating purposes.

Plating Vat. A vessel provided with the necessary bars for suspending articles to be electroplated in the bath of electrolyte.

Platinoid. A high resistance alloy used for rheostats, etc., with a fairly low temperature coefficient, similar in its composition to German silver but with the addition of tungsten.

Platinum Contacts. The actual contact surfaces where currents have to be made and broken frequently, as in electric bells, tremblers of induction coils, and contact breakers in electric ignition apparatus, made of the metal platinum because it is less damaged by the sparking produced than any other metal and ensures a clean contact with less attention.

Platinum Standard (of Light). See VIOLET STANDARD.

Plenum Heating (Electrical). Heating by exposure to electrically heated elements of the incoming air in a plenum ventilating system either only to raise the air to the temperature of the interior to be ventilated or to a greater extent to supply the whole of the heating required.

Pliodynatron. A high vacuum thermionic oscillator with an additional grid maintained at a higher voltage than the plate, and used in a magnetic field to avoid the excessive generation of secondary electrons.

Pliotron. The name given to the first practical three-electrode *Thermionic Valve* to employ a high enough vacuum to rely on a pure electron discharge. Designed by I. Langmuir for use as an amplifier (from Greek word *πλειον*, meaning more).

Plough. The fitting carried under electric trams working on the open conduit system which makes contact through the slot with the conductors in the conduit. See **PLOUGH CARRIER**.

Plough Carrier. The frame under the car from which the *Plough* is suspended, often sliding in guides across the car so that the plough itself can be withdrawn automatically where the slot passes from between to outside the rails.

Ploughing (Electric). Systems of ploughing in which the plough is either hauled by stationary electric winches at the end of the field or by electrically driven tractors, or driven by electric motors on the plough carriage itself, arranged to haul in or pay out the cables by which they are supplied, as required.

Plug. A cylindrical tapered or split piece of metal, usually with an insulating handle, or an assemblage of more than one such pieces in one holder, used to make contact either between a flexible lead to which it is attached and a contact or contacts, in the interior of a *socket*, or between different conducting surfaces within the socket; used in resistance boxes, in earlier forms of central station switchboards for lighting circuits, and on telephone exchange switchboards where different portions of the plug make contact with the different springs of the receptacle or *Jack*, and at the same time alter their relative positions. See also **WALL PLUG**.

Plug: Answering, Calling, Coupler, Ignition, Infinity, Inspection, Magnetic, Sparking, Switch, Three-Pin,

Two-Pin, Vent, Wall, and Wander. See **ANSWERING PLUG, CALLING PLUG, etc.**

Plug Adapter. See **LAMP-HOLDER PLUG**.

Plug and Socket Connection. See **PLUG and WALL PLUG**.

Plug Cut-Out. See **PLUG FUSE**.

Plug Fuse. A form of *Fuse* in which the fuse wire is contained in a plug which can be withdrawn from fixed contacts for replacement by another plug. In some systems of plug fuses the plugs carrying different sizes of fuse wire are not interchangeable in the sockets, so that a larger fuse than that for which the circuit is intended cannot be inserted.

Plug-In Coil, Transformer, etc. A readily interchangeable pattern of coil, transformer, etc., with its terminals arranged so as to plug simultaneously into a suitable socket to be connected to the circuit (particularly in wireless apparatus).

Plug Switch. A switch in which the circuit is closed by the insertion of a removable plug and not by a hinged contact arm.

Plugging. A word used for a system of electric braking in which the connections of the motor are changed so that it tends to drive backwards, a current-limiting resistance being used.

Plunger Electromagnet. A solenoid with a movable iron core which is pulled in by the action of the current; sometimes with an external iron return magnetic circuit. Used where a strong pull is required over a considerable range of movement.

Plunger Switch. A switch in which the movable contact is in the form of one or more plugs or plungers fitting inside tubular sockets of porcelain or other material within which are fixed contact springs.

Plurostat. A compact motor-generator combined with transformer, resistances, etc., enabling current at various voltages and with other characteristics to be obtained from the mains for various forms of electro-medical treatment.

Plus Circuit. The part of the circuit in a system where duplex telegraph working is superposed on a metallic quadruplex line, which contains the duplex apparatus and lies between the middle point of a high resistance across the line wires, and the earth connection.

Pneumatic Brush-holder. A brush-holder in which the brushes are held down on the commutator partly by compressed air; adapted particularly to high speed commutators.

Pneumatic Control. See ELECTRO-PNEUMATIC CONTROL.

Pneumatic Electric Miner's Lamp. See COMPRESSED AIR LAMP.

Pneumatically Operated Switch. A switch in which the contacts are closed by means of compressed air. See ELECTRO-PNEUMATIC CONTROL.

Pocket, Stage. See STAGE-POCKET.

Pocket (Electric) Lamp. A miniature incandescent lamp complete with dry or other battery, or hand-worked generator, for carrying in the pocket.

Poggendorf Cell. The single fluid form of *Bichromate Cell*.

Point : Fusing, Neutral, Switch, and Wiring. See FUSING POINT, NEUTRAL POINT, etc.

Point Effect. The fact that a discharge is more readily produced at parts of a charged conductor forming sharp points than elsewhere owing to concentration of the potential. See WIND (ELECTRIC) and ST. ELMO'S FIRE.

Pointolite Lamp. Trade name for a form of *Thiugsten Arc Lamp* suitable for projection purposes owing to the small size of the light source.

Poisson's Theory of Magnetisation. An early form of the molecular theory of magnetisation in which it was not suggested that the molecules were themselves permanently magnetised, but only become so when the whole piece is magnetised.

Polar Angle, Arc, Pitch, and Span. See POLE ANGLE, POLE ARC, etc.

Polarisation. (1) The state that a primary or electrolytic cell is liable to get into, after current has been

flowing, whereby, owing to the presence of products of electrolysis of the electrolyte on the electrodes, a counter e.m.f. is produced. In ordinary zinc-carbon cells this effect is produced by bubbles of hydrogen collecting on the carbon electrode unless an oxidising agent or *Depolariser* is present. (2) See DIELECTRIC POLARISATION. (3) The production of definite poles in a piece of magnetic material by an external field. (4) The limitation of wave action such as light or other electric waves at right angles to the direction of propagation to certain planes. See POLARISED WAVES, etc. See also POLARISATION OF A FAULT.

Polarisation : Circular, Dielectric, Elliptic, and Plane. See CIRCULAR POLARISATION, DIELECTRIC POLARISATION, etc.

Polarisation Capacity. A measure of the degree of polarisation in a battery by the quantity of electricity which must pass through it before the maximum effect is produced.

Polarisation of a Fault. In cable testing, it is often found that the e.m.f. due to the exposed copper and the iron sheathing in contact with moisture is variable, due to a similar polarisation effect to that taking place in a battery. This is liable to cause variations in the e.m.f. in the fault, which introduces difficulties in fault localisation tests.

Polarised Ammeter. An ammeter for continuous current, the pointer of which is deflected in opposite directions by currents in opposite directions.

Polarised Armature. The *Armature* of a *Polarised Relay* consisting of soft iron in the field of a permanent magnet which gives it a polarity and causes the relay to respond only to currents in one direction.

Polarised Electromagnet. An electromagnet combined with a permanent magnet so that only a part of its field is due to the current in the winding. This is sometimes convenient, as it enables the core to be worked on the steep part of its magnetisation curve

where small changes in the excitation produce considerable changes of induction.

Polarised Relay. A *Relay* responding to currents in one direction only.

Polarised Sounder. A *Morse Sounder* in which the armature is given magnetic polarity by being in the field of a permanent magnet in order to gain sensitivity.

Polarised Waves. Light or other electric waves, in which the displacement at right angles to the direction of propagation is limited to certain planes. See **PLANE POLARISATION, CIRCULAR POLARISATION, and ELLIPTIC POLARISATION.**

Polariser. The gas adhering to the cathode of a primary on electrolytic cell causing *Polarisation*.

Polarity. The distinction between *North* and *South Poles* in magnets, or *Positive* and *Negative Poles* in electrical apparatus.

Polarity Indicator. Any instrument used to determine which is the positive pole and which the negative pole of a circuit, such as a centre-zero, or polarised ammeter or voltmeter, or an electrolytic device. See **POLE FINDING PAPER.**

Pole. (1) That part of a magnet where the lines of force leaving or entering the iron are concentrated and therefore the external magnetic effects appear. In dynamo electric machines, the limb of the field magnet where the flux passes across the air gap to the armature. In a compass needle the ends which point North and South respectively. See also **UNIT MAGNETIC POLE.** (2) One of the terminals of a generator, battery, etc., between which the full difference at potential of the circuit in question exists, or conductors, such as bus-bars, mains, etc., connected to such terminals. (3) A wooden, tubular steel, or concrete upright support for overhead lines, bedded in a single hole in the ground. Cf. **MAST and TOWER.**

Pole(s): "A," Analogous, Anchor, Antillogous, Auxiliary, Bevelled, Comb, Commutating, Consequent, Eccentric, Free, "H," Laminated, Magnetic, Main, Marked, Negative,

North, North Seeking, Positive, Reversing, Salient, Shaded, Shielded, Solid, South, South Seeking, Staggered, Stamped, Terminal, Tramway, Trolley, Unit, and Unmarked. See "A" **POLE, ANALOGOUS POLE,** etc.

Pole Angle. The angle subtended at the centre of the armature by the *Pole Face*.

Pole Arc. The length of the *Pole Face* measured circumferentially, sometimes expressed as a percentage of the *Pole Pitch*.

Pole Bevel. The portion of the *Pole Face* at the edge which slopes away from the armature instead of being concentric with it.

Pole Changer. A *Relay* used in some telegraph systems which reverses the connections of one or more circuits.

Pole Changing Control. The variation of the synchronous speed of an induction motor by alteration of the number of effective poles by regrouping the stator coils. Used in three-phase traction and ship propulsion to give economical reduced running speeds, as well as for starting.

Pole Changing Switch. A switch used for making the necessary changes of connections for *Pole Changing Control*.

Pole Core. The portion of the *Pole Piece*, usually cylindrical, but sometimes of rectangular section, lying within the field coil, to which the *Pole Shoe* is attached. Also called *Pole Shank*.

Pole End-Plates. Substantial plates between which the laminations are clamped in a laminated pole.

Pole Face. The surface of the pole in a dynamo, etc., which faces the armature across the air gap.

Pole Finding Paper. Paper prepared with a chemical solution which, when damped and laid across two poles of a circuit, causes a red mark to be left where touched by the positive pole owing to the electrolytic effect of the current passing through the paper.

Pole Horn. The end or tip of the pole face in a dynamo, etc., which projects beyond the pole core. See **LEADING and TRAILING POLE HORNS.**

Pole Indicator. See **POLARITY INDICATOR**.

Pole Line. A transmission *Line*, etc., of short spans, supported on wooden poles. Cf. **TOWER LINE**.

Pole Piece. The part of a field magnet pole bolted to or cast on to the *Yoke*, consisting of the pole core and pole shoe.

Pole Pitch. The circumferential distance apart of the centre line of contiguous poles in a dynamo, etc., i.e. the circumference (usually at the air gap), divided by the number of poles.

Pole Shank. See **POLE CORE**.

Pole Shim. See **SHIM**.

Pole Shoe. The solid or laminated extension bolted, screwed, or cast on to and wider than the pole core forming the actual pole face at the air gap of a dynamo, etc.

Pole Span. The *Pole Arc* or the *Pole Angle*.

Pole Strength. The force exerted by a theoretical magnetic pole concentrated at a point upon unit pole at unit distance. Usual symbol: *m*. (Also sometimes called *Quantity of Magnetism*.)

Pole Switch. See **MAST SWITCH**.

Pole Tip. The extreme end of the *Pole Horn*.

Pole-Type Condenser, Transformer, etc. A condenser, transformer, etc., of enclosed construction, suitable for mounting on a transmission line pole.

Pollak-Virag Writing Telegraph. A high speed system of telegraphy, in which currents in two electromagnets in the receiving instrument control the vertical and horizontal displacement of a mirror causing a spot of light to execute movements, approximating to the form of written letters, when a suitable series of current impulses, controlled by a perforated strip passing through the transmitting instrument, are passed through the line. The received message is recorded photographically.

Polycore Cable. See **MULTICORE CABLE**.

Polycyclic. An expression occasionally used for *Polyphase*.

Polymorphic. Capable of supplying more than one kind of current,

such as a set of different machines driven by one engine or motor, or a *Double Current Generator*.

Polyode. A *Thermionic Valve* with more than three electrodes, e.g. with several additional grids, as in a *Pentagrid Rectifier*.

Polyphase. Pertaining to an alternating current system where the circuit is divided into several branches or "Phases," the currents in which are displaced from one another in phase. See **TWO-PHASE** and **THREE-PHASE**, and Cf. **SINGLE-PHASE**.

Polyphase Alternator. An *Alternator* wound so that it gives currents in different branches of the circuit differing in phase with one another; usually *Three-Phase*, and sometimes *Two-Phase*.

Polyphase Commutator Motor. A motor similar in construction to a single-phase commutator motor, but wound for polyphase currents; not widely used in practice.

Polyphase Currents. Alternating currents, flowing in the various branches of a *Polyphase System* and displaced in phase from one another, i.e. reaching their maxima at different times in regular rotation.

Polyphase Generator. See *Polyphase Alternator*.

Polyphase Meter. A supply meter arranged to measure the total energy in a polyphase system in a single instrument either with a single movement or with two movements actuating separate dials, the readings of which have to be added together. See **THREE-PHASE METER** and **TWO-PHASE METER**.

Polyphase Motor. A motor for running on a polyphase circuit. See *Induction Motor*, *Three-Phase Motor*, etc.

Polyphase Power. The total *Power* (watts) flowing in a polyphase circuit. In the case of a balanced three-phase circuit measurable by a single *Wattmeter* and equal to $(\sqrt{3})EI \cos \phi$ (where *E* = the voltage between phases, *I* the current in each phase branch, and $\cos \phi$ is the power factor). When the

- phases are unbalanced, two wattmeters must be employed (see **TWO WATTMETER METHOD**), and correspondingly more for a higher number of phases.
- Polyphase System.** A system where the circuit is divided into several branches in which alternating currents differing in phase from one another circulate, reaching their maxima in regular sequence. See **TWO-PHASE** and **THREE-PHASE SYSTEMS**.
- Polyphase Winding.** A winding composed of several sections forming separate branches of the circuit and symmetrically spaced as regards their angular position according to the number of phases. See **THREE-PHASE WINDING**, **TWO-PHASE WINDING**, etc.
- Polystage Amplifier.** See **MULTISTAGE AMPLIFIER**.
- Pony Motor.** A name sometimes given to an auxiliary motor, used to bring synchronous machinery up to speed.
- Porcelain Insulator.** An insulator for line wires or other purposes made of a hard quality of porcelain containing Kaolin mixed with quartz and silicates. See **PIN** and **SUSPENSION TYPE INSULATORS**, etc.
- Porcelain Interior.** A block of porcelain to carry terminals for attachment of cables or wires, and made of a suitable shape to fit into a junction box and to keep conductors of opposite polarity well apart.
- Porous Cell or Pot.** A vessel of porous earthenware, employed in primary and electrolytic cells to separate different liquids used in different parts of the cell, while allowing conductive contact between them. See **TWO-FLUID CELL**.
- Porret's Phenomenon.** An increase in the diameter of a nerve at the positive pole of the circuit when a current is made to pass through it.
- Portable Electrometer.** A portable form of the *Absolute* (attracted disc) *Electrometer*.
- Portable Instruments.** Measuring instruments which can be carried about and used for testing pur-

- poses without requiring elaborate setting up, as distinguished from *Switchboard* and other fixed *Instruments*.
- Portable Lamp.** An expression usually limited to hand lamps. Cf. **PORTABLE STANDARD**.
- Portable Receiver (Wireless).** A complete self-contained wireless receiving set, usually with a frame aerial and with all the batteries, and a loud speaker within the same case, which can easily be carried about.
- Portable Standard.** An electric light fitting attached to a flexible cord for standing on the floor or on a table.
- Portable Substation.** A railway car, or cars, carrying complete substation equipment, which can be sent to any part of a railway system and connected to the high tension lines to form a temporary substation for assisting in the current supply to the track for dealing with special traffic, etc.
- Portable Transmitter (Wireless).** A complete wireless transmitting equipment of moderate power which can be transported from place to place.
- Portative Force.** An expression sometimes used for the lifting power of a magnet.
- Position Finding, Radio-Acoustic.** See **RADIO-ACOUSTIC POSITION FINDING**.
- Position Indicator (in Electric Lifts).** A device on a landing showing by illuminated signals or otherwise at which floor the car is. See also **DIRECTION INDICATOR**.
- Positive Brush.** (1) Of a dynamo, the brush from which the current, according to the usual convention, leaves the machine. (2) Of a motor, the brush where the current enters the motor, being that connected to the positive pole of the circuit.
- Positive Carbon.** The carbon in a direct current arc lamp connected to the positive pole of the circuit, being that in which the *Crater* forms; usually of larger diameter than the *Negative Carbon*.
- Positive Charge.** The quantity of positive electricity contained by a

positively electrified body. See **POSITIVE ELECTRIFICATION**.

Positive Column. The luminous space starting from the positive pole in a moderately exhausted vacuum tube which, if the exhaustion is higher, breaks up into *Striae* and is separate from the glow surrounding the negative pole by *Faraday's Dark Space*, i.e. when the gas pressure is below about 1/500 of an atmosphere; it finally disappears when the gas pressure is below 1/10,000 of an atmosphere.

Positive Current. An expression to be avoided, but sometimes used: (1) When an electric current was considered as being made up of two components respectively of positive and negative electricity flowing in opposite directions, for that from the negative pole. Cf. **NEGATIVE CURRENT**. (2) In telegraphy, for a current in the direction making the signals. See **MARKING CURRENT**.

Positive Electricity. Electricity of the kind producing the phenomena of *Positive Electrification*, and opposite in properties and capable of neutralising *Negative Electricity*. At one time regarded as an entirely different entity from positive electricity (see **TWO FLUID THEORY**), or as an excess of one kind of electricity (see **ONE FLUID THEORY**). Modern theories point to an opposite view in that it is now regarded as a deficiency of negative *Electrons* or units of negative electricity. There is, however, a corresponding unit of positive electricity sometimes called the *Proton*, and according to the *Nuclear Theory* the central portion of all atoms is made up principally of these.

Positive Electrification. The production in a body of a *Positive Charge*, e.g. by the friction of vitreous substances, such as glass upon silk (see **VITREOUS ELECTRIFICATION**), or by induction from a negative charge. Apart from its powers of attraction for negatively charged bodies, a state of positive electrification can be distinguished by differences in the form of the *Brush Discharge*, in the discharge in an exhausted

tube, and by the characteristic forms assumed by *Lichtenberg Figures*. See also **POSITIVE POLE**, and cf. **NEGATIVE ELECTRIFICATION**.

Positive Electrode. In a primary cell, the plate (usually copper or carbon) from which, according to the original convention, the current was regarded as leaving the cell; in electrolytic cells, arc lamps, vacuum tubes, and other apparatus the conductor connected to the positive pole of the apparatus supplying the circuit.

Positive Electron. An expression sometimes used for the smallest quantity of positive electricity that can exist, i.e. the counterpart of the *Negative Electron*. In view, however, of their different natures, it is preferable to limit the term electron to the negative unit. See also **PROTON** and **POSITRON**.

Positive Element. A name sometimes given to the electrode of a primary cell to which the current flows inside the cell, i.e. what is called the *Negative Electrode* or *Pole* from the point of view of what happens outside the cell. Usually of zinc.

Positive Ion. An atom or molecule, from which electrons have been detached in the process of *Ionisation* and therefore carries a positive charge.

Positive Feeder. A *Feeder* connected to the positive side of the system.

Positive Main. The supply main connected to the positive bus-bar in a generating station or sub-station.

Positive Plate. The *Positive Electrode* of a primary, or, more usually, of a secondary cell. In the case of a lead accumulator, distinguished from the negative plate by its brown colour.

Positive Pole. In a generator, cell, or system of supply, the terminal from which, according to the original convention, the current was regarded as flowing out, e.g. the copper plate of a *Daniell Cell*. In apparatus where current is utilised, the terminal connected to the positive terminal or pole of the generator or system. It should be noted that in the case of an

accumulator both these definitions apply. The positive pole is connected to the positive pole of the generator during charging, and remains the positive pole of the cell from which the current flows out on discharge.

Positive Ray Analysis. Investigation into the composition of atoms by the *Mass Spectrograph*.

Positive Rays. Radiation consisting of projected streams of positive ions projected at a high speed from the anode of a partially exhausted discharge tube; capable of being deflected by a magnetic field. (Also called *Canal Rays*, *Anode Rays*, and *Diacathode Rays*.) See also *MASS SPECTRUM*.

Positive Wire (in Telephony). The wire forming that side of a telephone circuit within the exchange, normally connected to the positive side of the battery.

Positron. A particle of negligible mass and unit positive charge (i.e. the positive equivalent of a negative electron) emitted by certain elements such as aluminium when bombarded by *Alpha Particles*, only existing for a very short time.

Post Binding. See *BINDING POST*.

Post Head. A feeder terminal on a post for connection by a short length of cable to a conductor rail.

Post Office Bridge. A form of *Wheatstone's Bridge*, with the ratio and bridge resistances in a single box, controlled by plugs and compactly arranged with the battery and galvanometer keys, and terminals to which the battery, galvanometer, and unknown resistance are connected.

Pot, Explosion and Porous. See *EXPLOSION POT* and *POROUS CELL*.

Potassium Cell. See *PHOTOELECTRIC CELL*.

Potency, Magnetic. See *MAGNETIC POTENCY*.

Potential (Electric). The quality, analogous to pressure, which tends to cause a flow of electricity from a point where it is higher to a point where it is lower. The absolute potential of a body is measured theoretically by the work that

would be done in bringing up a unit charge to the body from infinity. In practical work we are more often concerned with the difference between the potentials at two points, for that is what tends to produce a current between them. *Difference of potential* is caused in a circuit by Electromotive Force and is usually measured in volts. Usual symbol: V .

Potential: Absolute, Concentration of, Constant, Contact, Earth, Electrode, Grid, Magnetic, Single, and Zero. See *ABSOLUTE POTENTIAL*, *CONCENTRATION OF POTENTIAL*, etc.

Potential Coupler. See *CONDENSER COUPLER*.

Potential Difference (P.D.). In the case of an open circuit the p.d. between two points, such as the terminals of a cell, is the same as the e.m.f. This is not, however, the case when a current is flowing, as the p.d. is then equal to IR where I is the current flowing and R is the resistance of that part of the circuit between the two points in question only, and not of the whole of the circuit. The expression is used of any two points in a circuit, even where there is no source of e.m.f. between them, and in that case is often spoken of as *Potential Drop*. Symbol: V . See *POTENTIAL*.

Potential Divider. A high resistance, used like a *Potentiometer*, to obtain, across a portion of it, a potential difference equal to a known fraction of the potential difference across the whole of it; or a series of fixed or variable capacitors employed for the purpose.

Potential Divider, Condenser. See *CONDENSER POTENTIAL DIVIDER*.

Potential Drop. See *POTENTIAL DIFFERENCE*, *DROP OF VOLTAGE*, etc.

Potential Front. The steep front portion of a wave of e.m.f. in a case like that of an inductive circuit to which an e.m.f. has suddenly been applied and the current is taking an appreciable time to grow to its full value. Owing to the steep slope of the curve of potential

along the conductor there can be a very considerable difference of potential between points comparatively near together, such as between the first few turns in a winding.

Potential Fuse. A fine wire fuse in a circuit across a high voltage system such as that of a voltmeter.

Potential Galvanometer. A galvanometer of sufficiently high resistance that it can be used as a voltmeter with its readings sensibly proportional to the voltage.

Potential Gradient. The difference of potential per unit length along a conductor or through a dielectric, i.e. the slope of the curve connecting potential and distance.

Potential Indicator. A device for indicating whether a circuit or conductor is *alive* or not. (Also sometimes used for a *Voltmeter*.)

Potential Regulator. See VOLTAGE REGULATOR.

Potential Slope. See POTENTIAL GRADIENT.

Potential Transformer. See VOLTAGE TRANSFORMER.

Potentiograph. An instrument of the *Potentiometer* class, arranged to be self-setting automatically and to give a continuous record of the position of the slider.

Potentiometer. (1) An instrument for measuring potential difference by balancing it against the drop of potential between two points on a slide wire or other adjustable resistance carrying a constant current which has previously been adjusted so that the slide leads reads direct in volts by a similar comparison with a standard cell; in another but less used method, a fixed resistance is used the current through which is varied and measured. See also DEFLECTION POTENTIOMETER. (2) A *Potential Divider*.

Potentiometer: Deflection, Drysdale, Grid, and Recording. See DEFLECTION POTENTIOMETER, DRYSDALE POTENTIOMETER, etc.

Potentiometer Braking Controller. A controller providing for braking position by putting the field and rheostat in series on the line and

connecting the armature to different points on the rheostat.

Potentiometer Control. Any form of control in which a variable voltage is applied by means of a sliding contact tapping off a variable portion of the drop of potential along a resistance carrying a steady current.

Potentiometer-Type Field Rheostat. A field rheostat in which the resistance is connected across the mains and one end of the field winding is connected to the moving contact, while the other is connected to one pole if reversal is not required, or if reversal is required, to the centre point of the resistance. By this means a very gradual control through zero to reverse can be obtained.

Pothead. An insulator for making a sealed joint between an underground cable and an overhead line.

Potter Diagram. A vector diagram showing the relations between current, impressed field, armature reaction, and voltage, used in determinations of alternator regulation; strictly applicable only to machines with non-salient poles.

Potter-Bucky Grid. A grid of edge-wise lead strips placed between the object and the plate in "X" Ray Photography to eliminate the effect of scattered rays and to sharpen the image.

Poulsen Arc. An arc burning under special conditions connected to an oscillating circuit in which, owing to its inherent instability, it maintains powerful continuous oscillations which are used for the production of continuous waves for wireless telegraphy and telephony. The arc usually burns in hydrogen between a rotating carbon cathode and a water-cooled copper anode in a magnetic field.

Poulsen System of Wireless Telegraphy and Telephony. A system in which continuous waves are employed generated by a *Poulsen Arc*.

Poulsen Telegraphone. See TELEGRAPHONE.

Powders, Electroscopic. See ELECTROSCOPIC POWDER.

Power (Electric). (1) The energy

expended in a circuit per unit time, measured in watts, by the product of the current and the voltage, and (in the case of alternating currents) the power factor. Symbol: *P*. (2) The application of electrical energy by means of electric motors to the driving of machinery or the performing of other mechanical work.

Power: Apparent, Blind, Distortive, Harmonic, Instantaneous, Mean, Polyphase, Reactive, Real, Thermoelectric, and Wattless. See APPARENT POWER, BLIND POWER, etc.

Power Amplifier. An expression sometimes used in wireless reception for a low frequency amplifier for use as a final stage, particularly with a loud speaker of large size.

Power-Circuit. (1) A circuit separate from the lighting circuit, for the supply to electric motors, etc., where supply for power purposes is charged for at a different rate from that for lighting. (2) The circuit on an electric train which carries the current to the motors. Cf. *Control Circuit*.

Power-Component (of current or voltage). See ACTIVE CURRENT, VOLTAGE, and VOLT-AMPERES.

Power-Factor. The ratio of the watts in an alternating circuit to the total equivalent volt-amperes; equal (in the case of sinusoidal currents) to the cosine of the angle of lag between the voltage and current.

Power-Factor, Inverse. See INVERSE POWER FACTOR.

Power-Factor Compensation. The adoption of special means to improve the power-factor of a circuit by the introduction of apparatus such as *Capacitors*, overexcited *Synchronous Motors*, or *Phase Advancers*, which tend to cause the current to *Lead* instead of *Lag* with respect to the voltage.

Power-Factor Indicator or Meter. An instrument for measuring the angle of lag between the current and the voltage in an alternating circuit and determining the power factor. One form consists of a moving system containing two voltage coils at

right angles, traversed respectively by currents in phase with and at a considerable phase displacement from the voltage, free to take up a position in the field produced by coils carrying the main current.

Power-Indicator, Remote. See REMOTE POWER INDICATOR.

Power-House. Another name for a *Generating Station*, applied more particularly to those supplying large systems.

Power-Load. That part of the load on a generating station which supplies electric motors, distinguished from that part supplying lighting. In alternating current systems, the power load has usually a worse (lower) power-factor than the lighting load, unless special precautions are taken.

Power-Line. (1) A *Transmission Line* conveying electric power over a long distance. (2) See *Bus Line*.

Power-Meter. (1) An instrument for measuring the power in a circuit, taking into account the power-factor in the case of alternating currents, i.e. a wattmeter. (2) Where there are separate meters for the power and lighting circuits of an installation, that for the *Power Circuit*.

Power-Peak. The peak in the *Power-Load* curve, not necessarily coinciding with the *Lighting Peak*.

Power-Ringing (Telephony). Ringing by alternating current from a power-driven generator.

Power-Station. See POWER-HOUSE.

Power-Valve. (1) A valve for a *Power Amplifier*, or for the last stage of low frequency amplification, taking a higher filament current and anode voltage than other receiving valves, and capable of dealing with a considerable grid voltage swing while still working on the straight part of its characteristic. (2) A large *Thermionic Valve* used as a main oscillator in a wireless transmitting station.

Poynting's Theorem. A theorem in connection with the flow of energy through an electromagnetic field, to the effect that the rate at which the energy passes through unit area of a closed surface in such a field, is equal to the product of the electric

and magnetic forces integrated over the surface divided by 4π .

Practical Electrical Units. Such units as the *Ampere*, the *Volt*, the *Ohm*, the *Watt*, the *Henry*, and the *Farad* (and *Microfarad*), which are in common use for practical purposes and are convenient definite multiples or submultiples of the theoretical C.G.S. *Absolute Electromagnetic Units*.

Pragauss. A practical unit of magnetic flux density equal to 10^{-10} gauss.

Pragilbert. A practical unit of magnetomotive force equal to 10^4 Gilbert.

Pramaxwell. A practical unit of magnetic field equal to 10^8 Maxwells.

Pracostered. A practical unit of magnetic field equal to 10^{-10} Oersted.

Precipitation (Electrical). A method of separating dust, smoke, or fumes from furnaces and other gases, by the precipitating effect of a screen of wires or other electrodes charged at a high potential. The positive or *Active Electrode* is usually insulated, and the *Passive Electrode*, upon which the precipitated particles collect, is usually earthed. Such apparatus is sometimes called an *Electrofilter*.

Precipitation, Electrostatic. See PRECIPITATION.

Preeco's Formula. The statement that the fusing current of a conductor of given material is proportional to the 1.5 power of the diameter.

Prepayment Meter. A supply meter in which the current can only be closed by, or after, the insertion of a coin in a slot, and arranged to break the circuit again after a definite quantity of energy has been consumed.

Prescot Meter. An electrolytic prepayment meter depending on the dissolving away of a portion of a strip of copper foil acting as one electrode.

Prescot Wiring System. An interior wiring system distinguished by the use of circular lead sheathed twin cable with wires of 11 section.

Presselector (in Automatic Telephony).

A *Selector* to connect the calling subscriber's line to a vacant selector by which the connection to the required line is made through further selecting apparatus. (Also called *Subscriber's Rotary Line Switch*, or simply *Line Switch*.)

Press, Lead. See LEAD-PRESS.

Pressboard. See PRESS-SPAHN.

Press-Button. See PUSH-BUTTON.

Pressel Switch. See PENDANT SWITCH.

Press-Spahn. A homogeneous fibrous material made from wood pulp, with a glossy surface, used in thin sheets as an insulating material and less liable to retain moisture than paper or cardboard. A similar material is called *Press-Board* or *Fuller-Board*.

Pressure. An expression often used industrially for *Difference of Potential*, *Electromotive Force*, or *Voltage*.

Pressure : Critical, Extra-High, High, Low, and Medium. See CRITICAL PRESSURE, EXTRA-HIGH PRESSURE, etc.

Pressure Cable. See GAS PRESSURE CABLE.

Pressure Circuit. See VOLTAGE CIRCUIT.

Pressure Coil. A coil, as in arc lamp regulating apparatus, connected across the circuit, to be traversed by a current proportional to the voltage. Cf. CURRENT COIL, and see *Pressure Circuit*.

Pressure Controller. A device for causing the output voltage of a transformer to increase as the load rises) consisting of two reactors, one with an air gap in its core and the other with a saturated core connected in series between the end terminals and a tapping, the output voltage being taken from the point between them.

Pressure Drop. See POTENTIAL DROP.

Pressure Regulation. See VOLTAGE REGULATION.

Pressure Transformer. See POTENTIAL TRANSFORMER.

Pressure Winding. See PRESSURE CIRCUIT.

Pressure Wire. A wire making a connection to a pressure coil, circuit, or winding.

Preventive Coil. A small choking coil connected between two parts of

the moving contact in a multiple contact switch, connected to tapings of a transformer; to avoid short-circuiting the individual coils when passing from one step to another.

Preventive Leads. Connections between armature coils and commutator segments in single-phase commutator motors, of high resistance, to limit the short-circuit current when a brush is passing over two segments under bad conditions of commutation. See *Preventive Resistance* (2).

Preventive Resistance. (1) A resistance placed between two halves of the moving contact of a multiple contact switch, such as an accumulator regulating switch, to prevent short-circuiting individual cells, etc., when moving from one contact to the next. Cf. *PREVENTIVE COIL*. (2) A resistance in a preventive lead in an alternating current motor.

Price's Guard Wire. A device used in insulation tests of cables in tanks, etc., to avoid the leakage current across the surface between the exposed ends of the conductor being added to the leakage current through the insulation; consisting of a wire wrapped round the insulation at both ends and connected to the testing circuit, so that there is no difference of potential between the end of the conductor and the point over the insulation where the guard wire is attached.

Primary. Abbreviation often used for the *Primary Winding* of a transformer.

Primary Battery. More than one *Primary Cell* connected together.

Primary Cell. A cell consisting of electrodes in an electrolyte which gives an electromotive force, and can maintain a current owing to irreversible chemical action within the cell. The energy is derived from the gradual chemical change or consumption of the material of the electrodes. Cf. *SECONDARY CELL*. See *VOLTAGE CELL*.

Primary Circuit. The circuit including the primary winding of a transformer. Cf. *SECONDARY CIRCUIT*.

Primary Clock. The principal or *Master Clock*, in a system of

electrical time service, which controls the current impulses actuating the clock dials throughout the system.

Primary Coil. The whole or part of the *Primary Winding* of a *Transformer*.

Primary Current. The current in the *Primary Winding* of a *Transformer*, *Induction Coil*, etc.

Primary Electrons. An expression sometimes used for the main stream of electrons emitted by the cathode of a thermionic valve as distinct from so-called *Secondary Electrons*, which may be detached from the plate by the bombardment of the primary electrons.

Primary Luminous Standard. A standard of luminous intensity (candle-power) constructed in accordance with a recognised specification.

Primary Standard. A *Standard* agreed upon as representing some *unit*, carefully preserved at a National or International Laboratory, etc. Cf. *SECONDARY STANDARD*.

Primary Voltage. The voltage at the terminals of the primary winding of a transformer, which may be higher or lower than the secondary voltage, according to whether the transformer is stepping down or up in voltage.

Primary Winding. The winding of a transformer which is connected to the source of supply irrespective of whether the voltage in it is higher or lower than that of the *Secondary Winding*.

Prime Conductor. The insulated conductor in a frictional electric machine to which the collectors deliver the charge from the rubbed cylinder, plate, etc., forming the main terminal of the machine.

Printing Multiplex (Telegraph) System. A *Multiplex* system applied to a *Type Printing Telegraph System*, such as the *Baudot* system. Spoken of as double, treble, quadruple, quintuple, or sextuple, according as 2, 3, 4, 5, or 6 ways are provided for. Cf. *MORSE MULTIPLEX SYSTEM*.

Printer. Start-Stop. See *START-STOP PRINTER*.

Printing Telegraph. See TYPE PRINTING TELEGRAPH, TELETYPE, etc.

Printing Telegraph: Baudot, Creed, Hughes, Murray, and Stajles. See BAUDOT PRINTING TELEGRAPH, CREED PRINTING TELEGRAPH, etc.

Printometer. An attachment to a supply meter which records the maximum demand every half-hour in printed figures.

Prismatic Compass. A portable magnetic compass with pivoted needle and a scale of degrees round the inside of the case, by which bearings of any object can be taken by prismatic sights, which enable the object and the scale to be seen at the same time.

Private Branch Exchange Final Selector. A selector at a private automatic branch exchange which acts as a final selector and also finds a vacant line.

Programme Circuit. A Telephone Circuit specially balanced to be able to deal with a larger range of frequencies than that required for ordinary speech, so as to be used for the transmission of musical programmes over long distances for broadcasting purposes.

Progressive Scanning (in Television). A system of Scanning in which contiguous lines of the field are covered successively in order. Cf. INTERLACED SCANNING.

Projected Scale Instruments. *Measuring Instruments* in which the position of the moving part is made visible by optical projection on a screen.

Projector. (1) An apparatus containing an arc or other electric lamp and a system of mirrors or lenses by which as much as possible of the light is concentrated into a beam in the required direction, either for localized illumination, as in a *Searchlight* projector, for stage or decorative lighting, or, in conjunction with a suitable optical system, for throwing images on a screen as in a cinematograph projector, or in the case of ordinary lantern slides. (2) A loud speaking telephone receiver with horn for projecting the sound chiefly in one direction.

Projector Lamp. An electric lamp arranged to give a powerful light chiefly in one direction, from as small a luminous source as possible for use in a *Projector*. In the case of an arc lamp, having the crater as unobstructed as possible on the side facing the mirror or lens, and with the regulating mechanism so arranged that the feeding of the carbons does not alter the position of the arc, whether the feed is by hand or automatic, and provided with convenient means for adjusting the longitudinal and transverse position of the arc. In the case of *Projector-Type Filament Lamps*, with the filament so disposed that it forms as small a light source as possible. See FOCUS LAMP.

Projector-Type Filament Lamp. See PROJECTOR LAMP.

Prolongation. The continuance of a telegraph signal current after the source of e.m.f. has been disconnected from the line by the gradual discharge of the condenser formed by the capacity of the line, or the continuance of a current in an inductive circuit after the e.m.f. has ceased.

Proofed Tape. Cotton cloth, impregnated with india-rubber, for insulating purposes.

Proof-Plane. A small piece of conducting material mounted on a highly insulating handle, for receiving a sample of the charge of a body with which it is brought in contact, in order to ascertain whether the charge is positive or negative, by means of an electro-scope.

Proof-Plane, Magnetic. See MAGNETIC PROOF-PLANE.

Propagation. The "propagation" of a current along a conductor does not mean the flow of the current in the ordinary sense, but is an expression used to signify the travel of current waves disturbances or changes in value along it. In the case of simple wires or cables of moderate length this is practically instantaneous, but in submarine cables of considerable length, the time of propagation reaches appreciable values depending on the constants of the line,

i.e. its *Capacitance, Inductance, Conductance, and Leakage*.

Propagation Constant. A quantity on which the rate of propagation of waves in a particular circuit depends, equal to $\sqrt{(R+jpL)}\sqrt{(S+jpC)}$ where R , L , S and C are respectively the resistance, inductance, dielectric conductance, and capacitance per mile, in the usual units, and p is the pulsation. It is often written $\alpha + j\beta$ where α is the *Attenuation Constant* and β the *Wave Length Constant* of the line.

Propagation Distance or Length. The distance of a point on a cable or line from the source of the e.m.f. multiplied by the *Propagation Constant* of the circuit.

Proportional Coils. The resistance coils in the *Ratio Arms* of a *Wheatstone's Bridge*.

Propulsion of Ships, etc. (Electrical). Propulsion of vessels in which the propellers are driven by electric motors directly coupled to their shafts, whether the current therefor is obtained from accumulators carried on board or by generators on board driven by the main steam or internal combustion engines, or turbines. A variable speed ratio is thus possible which enables both the engines or turbines and the propellers to be run at their most economical speed in all circumstances.

Proscenium Lights. Rows of incandescent lamps for stage lighting placed round the back of the proscenium arch. See *STAGE LIGHTING*.

Prospecting (Electrical). Investigation regarding the presence of metaliferous ores, etc., by measurement of ground resistivity.

Protected Cut-Out or Fuse. A fuse so shielded as to protect the operator from injury in the event of blowing on replacement.

Protected Motor. A motor with end shields affording mechanical protection to the armature, commutator, etc., but with sufficient apertures to allow for efficient natural ventilation.

Protected Switchgear. Switchgear

with the live parts shielded from accidental contact with persons.

Protection Cap. See *FENDER*.

Protection: *Cathodic, Feeder, Flange, Gauze, Labyrinth, Lightning, Plate, and Tubular.* See *CATHODIC PROTECTION, FEEDER PROTECTION, etc.*

Protective Device. See *PROTECTIVE GEAR, RELAY, etc.*

Protective Device: *Buchholz, Over-voltage, and Transient.* See *BUCHHOLZ PROTECTIVE DEVICE, OVERVOLTAGE PROTECTIVE DEVICE, etc.*

Protective Gear. All the apparatus connected with a system of protection of generating plant, mains, etc., from injury due to heavy short-circuit currents by automatically opening the circuit at an appropriate point on the occurrence of abnormal conditions.

Protective Relay. A relay for actuating the trip gear of a circuit breaker upon the occurrence of abnormal conditions, such as overloads, reverse currents, or the dropping of a current below a predetermined minimum value, made to operate either as instantaneously as possible or after the abnormal condition has persisted for a fixed time or a period depending upon its severity.

Protective Sheath. See *EARTH SHIELD*.

Protective Spark Gap. A spark gap in parallel with the terminals of a piece of electrical apparatus to protect it from excess pressure by allowing a spark to pass as soon as a certain pressure is reached. Also called *Safety Gap*.

Protective System. A system of auxiliary apparatus in generating stations, distribution networks, substations, etc., which ensures that the circuit is automatically broken on the occurrence of abnormal conditions which, if allowed to persist, would produce damage by excessive currents or pressures in the apparatus, cables, etc., either simply by the action of fuses or by the opening of circuit-breakers, sometimes through the medium of relays through which currents are caused to flow when a balance due

to normal conditions is upset by a fault or otherwise.

Protective System: Beard, Biased Differential, Bowden-Thomson, Buchholz, Core-Balance, Discriminating, Duplex, Ferranti-Hawkins, Howard, Interlock, Leakage, Merz-Hunter, Merz-Price, Mid-Point, Ratio-Balance, Self-Balancing, Split-Conductor, Split-Pilot, Translay, and Whittaker. See BEARD PROTECTIVE SYSTEM, BIASED DIFFERENTIAL PROTECTIVE SYSTEM, etc.

Protector. A lightning arrester, fuse, or both combined, for a telephone circuit.

Protector Springs. The spring clip contacts holding a *Heat Coil* or other *Protector* in a telephone exchange.

Proton. The smallest quantity of positive electricity that is at present known to be able to exist in a free state; being that carried by the nucleus of a hydrogen atom; forming a unit of positive electricity in the same sense that an *Electron* is of negative electricity. According to the *Nuclear Theory* of the construction of the atom the nucleus of the atom contains one or more protons, each having a mass about 1,840 times that of an electron, i.e. about $1.86 \cdot 10^{-24}$ gramme, sometimes associated with a limited number of electrons, surrounded at a distance of about 10^{-13} cm. by a number of "satellite" electrons moving in orbits.

Pseudo-Dielectric. A substance such as glass, containing in its liquid state a large number of free ions, the lack of conductivity of the solid being due not to the absence of the ions but to their lack of mobility.

Psi (Ψ). Symbol for *Electrostatic Flux*.

Psycho-Galvanic Phenomenon or **Psycho-Galvanic Reflex.** Alteration of electrical constants of parts of the body, such as a fall in resistance of the skin, under the influence of mental excitement.

Puissancegraphe. A variety of the *Ordograph* for tracing curves of *Instantaneous Power* in an alternating current circuit in which a

form of wattmeter replaces the ammeter or voltmeter.

Pull: Magnetic and Unbalanced Magnetic. See MAGNETIC PULL and UNBALANCED MAGNETIC PULL.

Pulled Coils. *Armature Coils* wound with parallel sides close together and afterwards pulled out into the usual diamond form.

Pull-Out Torque. The value of the overload torque at which an induction motor "pulls out" or falls out of synchronism.

Pull Switch. See CEILING SWITCH.

Pulsance. See PULSATION (1).

Pulsating Current. A current which rises and falls in regular waves equivalent to an alternating current superposed on a steady direct current; usually including only cases where the direct component is large enough for the current always to be unidirectional but sometimes including alternating currents with greater waves in one direction than in the other.

Pulsating Flux. Magnetic flux rising and falling in value regularly, due, for example, to periodic variations in the reluctance in the magnetic circuit of a machine owing to the changes in relative position of the teeth, pole pieces, etc.

Pulsation. (1) An expression sometimes used for the angular velocity of the vector expressing an alternating current voltage, etc. Equal (in radians per second) to 2π times the frequency. Usual symbol ω (Greek "omega"), also called *pulsance*. (2) In the case of a varying frequency, or speed, the ratio of the difference between the maximum and minimum values to the average value.

Pulsation of Flux. See PULSATING FLUX.

Pulse (Electric). See IMPULSE.

Pump, Motor. See MOTOR-PUMP.

Pump Motor. A motor specially designed for driving a pump, such as a vertical shaft squirrel cage waterproof motor, directly coupled to a centrifugal pump for lowering down a mine shaft during sinking operations, etc. See SUBMERSIBLE MOTOR, WATERTIGHT MOTOR, etc.

Pumping Plant (Electric). Pumping plant in which the pumps are

driven by electric motors either directly coupled, as usually the case with centrifugal pumps, or through gearing, as is usually the case with plunger pumps. Electrically driven pumps may be controlled automatically according to water-level or pressure.

Puncher. See PERFORATOR.

Punchings. See LAMINATIONS.

Puncture of Insulation. The destruction of the continuity of insulation by a spark discharge through it.

Puncture Proof Insulator. An insulator designed to flash over, without damage, at a lower voltage than that which would effect puncture of the insulating material.

Puncture Strength. The power of an insulator to resist puncture, expressed as the maximum voltage it will stand without breakdown per centimetre thickness.

Puncture Voltage. The actual voltage necessary to cause breakdown of a given insulator under conditions where it is gradually increased.

Puncture Voltage Test. A test of an insulator to determine the *Puncture Voltage*. Usually conducted under oil to enable a voltage higher than the spark-over voltage to be reached.

Pupin Coil. See LOADING COIL.

Pupinised Cable. A telegraph or telephone cable fitted with *Loading Coils*.

Pupin's Law. Two telephone lines, one with inductance evenly distributed and the other with *Loading Coils* at equal intervals, will be equivalent for transmission purposes if half the angle obtained by reckoning the wave length as 180° and dividing it by the number of coils per wave length is so small that its sine is approximately equal to its value in circular measure.

Pure Continuous Waves. Electric waves of unvarying amplitude and pure sine wave form without harmonics.

Pure Rotating Magnetic Field. A *Rotary Field* constant in strength and angular velocity in one plane.

Pure Solid Carbons. *Arc Lamp Carbons* of practically pure homogeneous carbon without the addition of chemical substances.

Push: Bell, Pear, Pendant, and Suspension. See BELL PUSH, PEAR PUSH, etc.

Push Button. An appliance for closing a circuit carrying a small current by pressure on a small button or plunger, arranged to break the circuit when released, used for ringing electric bells (see BELL PUSH) and for actuating control circuits, e.g. for tripping circuit-breakers, starters, etc.

Push Button Control. A control of motors, etc., by starters put in action through relays, etc., by auxiliary circuits closed by push buttons, e.g. in rotary printing presses where it is required to control the movement of the machine from various points.

Push Button Lift Control. The control of a lift through *Push Buttons*, so that pressure on a button at a landing causes the car to come to and stop at that landing, and pressure on a button in the car causes it to go to and stop at any landing chosen, with various forms of safety and emergency devices. See also AUTOMATIC and SEMI-AUTOMATIC LIFT CONTROL.

Push Button Switch. A switch opened and closed respectively by pressure on one or other of two buttons or plungers, or by repeated pressure on a single button.

Push-Pull, Quiescent. See QUIESCENT PUSH-PULL.

Push-Pull Microphone. See DIFFERENTIAL MICROPHONE.

Push-Pull System of Amplification.

An arrangement of the last stage of a low frequency amplifier in which two valves are used with both their grid and plate circuits connected as in a three-wire system, in opposite directions to tapplings on the input and output transformers respectively.

"P" Wire. The wire which controls the holding and releasing gear in automatic telephone equipment.

Pyr. A unit of luminous intensity, proposed in 1896 by a Congress at Geneva, and equal to one-tenth of the *Vielle Standard*.

Pyranol. A synthetic organic non-inflammable, non-explosive insulating and cooling medium.

Electric Heating. A method of heating higher flame temperature than ordinarily produced by application of an electric arc fuel nozzle.

Electricity. The property of crystals of becoming electric at opposite ends of their axes heated or cooled. See ANAL- and ANTILOGOUS POLES.

Electric Crystals. Crystals, such as tourmaline, which exhibit the phenomena of PYRO-ELECTRICITY.

Electric Generator. See DYNAMO-ELECTRIC GENERATOR.

Pyrometer (Electric). An instrument for measuring high temper-

atures by electrical means, e.g. by the variation of the resistance of a body exposed to the temperature or by the electromotive force given by a *Thermo-Couple*.

Pyrometer: Disappearing Filament, Monochromatic, Optical, Optico-Magnetic, Radiation, Thermo-Electric, and Resistance. See DISAPPEARING FILAMENT PYROMETER, MONOCHROMATIC PYROMETER, etc.

Pyron Detector. A *Crystal Detector* consisting of a contact between iron pyrites and a copper or other metallic point.

Q]

Q. Symbol for *Quantity of Electricity* and *Unit Charge*.

"Q. and I." Detector. An old name for a form of *Linemen's Detector* with two separate coils, one of low and the other of high resistance, for estimation of current and voltage, or, as they were formerly called, "quantity" and "intensity" respectively.

Q.E.S. Units. A name sometimes given to the *Practical Electrical Units* because they are based on the quadrant; the ten to the eleventh part of the gramme and the second.

Quad. A group of four conductors symmetrically placed, complete with their insulation, in a telephone cable.

Quad Cable. A telephone cable which contains a number of *Quad Cores*.

Quadrant. A term used at one time for the unit of *Inductance*, now called the *Henry*. Inductance has the same dimensions as length, and this unit is equivalent to 10^9 cm., which is approximately the length of one quadrant of the earth.

Quadrant Electrometer. A sensitive form of electrometer in which a suspended flat metal "Needle" is free to swing within a fixed system consisting of a flat cylindrical box divided into four quadrants, with each opposite pair connected but insulated from the other pair. If the pairs of quadrants are subjected to a difference of potential, then the needle (if highly charged) will be attracted into one and repelled out of the other. See also **HETEROSTATIC** and **IDIOSTATIC METHODS** and **REPLENISHER**.

Quadrantal Deviation or Error. (1) The effect on a ship's magnetic compass of the magnetisation induced by the earth field in the iron or steel hull of the ship, which is a maximum when the vessel is pointing N.E., S.E., S.W., or N.W., but

zero when pointing N., S., E., or W. Corrected by placing soft iron spheres one on each side of the compass, counterbalancing the effect the magnetism induced by the earth's field, which is also a maximum in each of the four quadrants. Cf. **SEMICIRCULAR**, **HEELING**, and **CARGO ERRORS**. (2) A similar error in wireless direction finders on aeroplanes due to the reaction of induced oscillations on the metal work of the fuselage.

Quadrature. Two periodic quantities, such as an alternating current or voltage, are said to be in "quadrature" when the phase angle between them is 90° . This is known as "Time Quadrature." The expression is also used of two points on an armature winding which are spaced 90° *Electrical Degrees* apart, this is known as "Space Quadrature."

Quadrature Component (of Current, Voltage, etc.). See **REACTIVE CURRENT**, **VOLTAGE**, etc.

Quadrupole. Any piece of apparatus or part of a circuit having a pair of input terminals and a pair of output terminals, usually limited to a "*Passive Quadrupole*," containing no internal source of e.m.f., e.g. one unit of a *Filter*.

Quadrupolar. With four poles. Cf. **BIPOLAR** and **MULTIPOLAR**.

Quadrode. See **TETRODE**.

Quadruple Phantom Circuit. A superposed circuit each side of which consists of the eight conductors of a *Double Phantom Circuit* in parallel.

Quadruplex (Telegraph) **System.** A telegraph system in which *Duplex* and *Diplex* working are so combined that four messages, two in each direction, can be sent simultaneously over a single line. Cf. **MULTIPLEX**.

Qualimeter. See **PENETROMETER**.

Quality (of "X" Rays). See **HARD "X" RAYS**.

Quantity of Electricity. (1) In *Electrostatics*, the amount of a charge, measured in units, such that unit quantities placed unit distances apart repel each other with unit force. (2) In electric currents, the amount of electricity that passes through a circuit in a given time to which the amount of substance deposited in an *Electrolytic Cell* is proportional, measured in *Coulombs*, i.e. the quantity of electricity which has passed when 1 ampere has flowed for 1 second, i.e. 10^{-1} C.G.S. electromagnetic unit. Symbol: Q .

Quantity of Light. The line integral of *Luminous Flux*. Symbol: L .

Quantity of Magnetism. See **POLE STRENGTH**.

Quantometer. A form of *Ballistic Galvanometer* in which the swing of the moving coil system is approximately proportional to the quantity of electricity that has passed through it; used for magnetic testing, etc., e.g. in the *Fluxmeter*.

Quantum Limit. The shortest wave length in an "X"-Ray spectrum, corresponding to the maximum voltage between the electrodes of the tube producing the rays.

Quantum Theory (Planck's). A theory of *Radiation* according to which atomic radiation can only take place in certain fixed units or blocks, the size of which is proportional to the frequency of the oscillations. Thus, *Planck's Quantum* of energy $\epsilon = h\nu$ (where ν is the frequency) or h/T (where T is the periodic time) h is known as *Planck's Constant* and has the dimension of energy \times time or "action." According to Bohr's view of the atom, such "quanta" of energy are radiated when electrons in an atom pass from one state to another. See also **PHOTON**.

Quarter-Phase. An expression sometimes used for *Two-Phase*.

Quarter Wave-Length Aerial. An aerial having an effective height equal to a quarter of the wave-length to be radiated. Cf. **HALF WAVE-LENGTH AERIAL**.

Quarter-Wave Transmission. Long distance alternating current transmission in which line losses and pressure drop are lessened by arranging the natural period of oscillation of the line to be equal to four times the frequency, so that resonance is produced. Cf. **HALF-WAVE TRANSMISSION**.

Quartz Lamp. A *Mercury Vapour Lamp* in a container or tube of quartz instead of glass. This enables increased current densities to be employed. It is also more transparent to ultra-violet rays.

Quartz Oscillator. A *Quartz* (or *Piezoelectric*) *Resonator* connected between the grid and one of the other terminals of a thermionic valve, and producing continuous oscillations when the circuit constants are suitable. Used for frequency control of transmitting stations and for standardising wavemeters.

Quartz Resonator. See **PIEZO-ELECTRIC RESONATOR**.

Quartzolite Heating Elements. Heating resistances composed of coiled wire enclosed in quartz tubes which can be run at a bright red heat.

Quasi-Arc Welding. The name given to a system of arc welding in which covered iron electrodes are used; the covering material protecting the molten metal which is being deposited on the work from the electrode from oxidation by the formation of a slag. The cover consists of an asbestos yarn impregnated with a fluxing compound wound on the electrode.

Quenched Arc Circuit-Breaker. An oil circuit-breaker with the moving contact in the form of a rod, surrounded by a series of heavy metal rings through which it is withdrawn. The arc is quenched by rapid withdrawal of heat causing de-ionisation and is to some extent stabilised by the presence of the magnetic material of the rings.

Quenched Spark. A spark in a wireless transmitting circuit on the *Spark System* which is effectively deionised to prevent the gap remaining conductive after

the actual spark has passed, so that only a few sharply defined oscillations take place.

Quenched Spark Gap. A spark gap arranged to give a *Quenched Spark*.

Quenched Spark System of Wireless Telegraphy. See **QUENCHED SPARK**.

Quick Break Fuse. A *Fuse* arranged to ensure rapid breaking of the circuit when the fuse wire melts, by the ends being quickly drawn away by a weight or otherwise.

Quick Break Switch. A switch provided with special arrangements to ensure the rapid separation of the contacts irrespectively of rate at which the handle is moved, to prevent possibility of persistence of an arc; often by means of auxiliary contacts which are pulled away by a spring after the main contacts have separated.

Quick Make-and-Break Switch. A switch in which the act of closing, as well as opening, is assisted by springs, and is independent of the rate at which the handle is moved.

Quiescent Carrier Telephony. A system of wireless telephony in which the carrier wave is suppressed

when transmission is not actually taking place.

Quiescent Push-Pull. An arrangement of a final amplification stage in a wireless receiver with the two output valves arranged on one transformer in *Push-Pull* connection and so connected that practically no current flows when a signal is not being received. The two sets of electrodes are sometimes placed in one bulb.

Quiet Automatic Volume Control. See **DELAYED AUTOMATIC VOLUME CONTROL**.

Quiet Tuning. Automatic reduction of or "Muting" of output of a wireless receiver at all times except when accurately tuned to an incoming carrier wave.

Quill Drive. A method of drive sometimes adopted on electric locomotives, etc., in which freedom of movement between an unsprung shaft and the armature of a motor mounted on the main frame is secured by building the latter on a hollow sleeve or "quill" surrounding the driven shaft and attached thereto by springs. (Cf. **INDEPENDENT AXLE DRIVE**).

Quintode. See **PENTODE**.

Quotient-Meter. See **RATIOMETER (2)**.

R]

R. Symbol for *Resistance*.

"R6" Automatic Telephone System.

A system employed in France for provincial exchanges, characterised by the use of common control circuits and single motion selectors.

Racing (of a Motor). The increase of speed, sometimes to a dangerous extent, in the case of a *Series Motor* when the load is thrown off, owing to the weakening of the field.

Rack Railway (Electric). A mountain railway where the gradient is too steep for the adhesion of smooth tyred wheels on an ordinary track to be relied on, and an extra toothed rail or "Rack" is used, into which a pinion on the locomotive or motor car gears. The shaft of this pinion is driven through further gearing by one or more electric motors. In many such cases three-phase induction motors are used to obtain the advantages of *Regenerative Braking* when travelling down hill. Cf. FUNICULAR RAILWAY.

Radial Brush Holder. A *Brush Holder* in which the direction of pressure of the brush is radial to the commutator, suitable for reversible machines. Cf. TRAILING and REACTION BRUSH HOLDERS.

Radial Commutator. A commutator in which the segments are arranged radially instead of to form a cylinder, so that the brushes bear upon the surface of a disc; sometimes used in special forms of traction motor where axial space is limited, and in rotary converters.

Radial Ducts. Ventilating ducts or channels in an armature, etc., running in a radial direction.

Radial Feeder. See INDEPENDENT FEEDER.

Radial Slots. Armature slots, in which the sides of the slots are radial instead of being parallel to a radius through the centre line of the slot.

[Rad

Radiant Efficiency. A term used in photometry for the percentage of the total energy radiated by a luminous source formed by that within the visible range of the spectrum.

Radiant Heat. Infra-red *Radiation* from bodies at temperature insufficient to cause visible light rays.

Radiant Heat Therapy. Treatment of disease by radiation of a wavelength between 4000 and 7000 Å.

Radiant Lamp Heater. The form of electric radiator in which the heating elements consist of large carbon filament incandescent lamps.

Radiating Circuit. An oscillating circuit such as the aerial of a wireless transmitting station, from which energy is being radiated in the form of *Electric Waves*.

Radiating Surface. A term often used for the total cooling surface of an armature, etc., exposed to the air, but strictly meaning only that portion thereof from which heat is radiated as distinguished from that from which it is dissipated by convection or direct conduction.

Radiation. The transfer of energy from a system by the sending out of waves of electrical disturbance through the "Ether" in the surrounding space, including the low frequency radiation or *Electric Waves* used in wireless telegraphy and telephony, the higher frequency waves or rays known as *Radiant Heat* or *Infra-Red Rays*, visible radiation or light rays of still higher frequency, invisible but chemically active called *Ultra-violet Rays*, and the extreme cases of "X" or *Röntgen Rays* and *Gamma Rays*. Recent researches regard radiation as being of a nature more allied to the emission of discrete corpuscles endowed with a property similar to mass

and known as *photons*, rather than being purely wave motion and point to the view that the energy of radiation from atoms is supplied by the slipping of electrons into orbits of less diameter, and that these changes take place suddenly, releasing successive photons. See QUANTUM THEORY, FLUORESCENCE, PHOSPHORESCENCE, and LUMINESCENCE.

Radiation: Characteristic, Corpuscular, Cosmic, Impulse, Penetrating, Photic, Secondary, Selective, Spontaneous, Temperature, Ultra-Gamma, Ultra-Photic, and Visible. See CHARACTERISTIC RADIATION, CORPUSCULAR RADIATION, etc. See also references under RAYS.

Radiation Coefficient. (1) See EMISSIVITY. (2) See RADIATION RESISTANCE.

Radiation Constant. The product of the *Radiation Height* of an aerial system and the *Aerial Current*.

Radiation Efficiency. The percentage of the energy supplied to an aerial which is radiated by it. Symbol η_r .

Radiation Factor. The *Radiation Constant* of an aerial system divided by the wave-length. Proportional to the square root of the power radiated.

Radiation Furnace. A variety of *Resistance Furnace* in which the resistor, which may be in the form of a carbon rod is not in contact with the charge and the heat is only transferred by radiation.

Radiation Height. See EFFECTIVE HEIGHT.

Radiation Pyrometer. A pyrometer such as the Féry Pyrometer, in which the temperature of part of a furnace, etc., is measured by focusing the rays of radiant heat from the body on to a thermojunction and finding its temperature rise from the e.m.f. produced. This determines the amount of the radiation to the fourth power of which the temperature of the source is proportional. The galvanometer to which the thermojunction is connected can therefore be graduated to read the temperature of the source directly in degrees.

Radiation Resistance. See AERIAL RADIATION RESISTANCE.

Radiation Thermostat. See EUPATHEOSTAT.

Radiative Circuit. An *Oscillating Circuit* which is capable of radiating energy.

Radiator (Electric). An apparatus for heating rooms, etc., by radiation of heat from a set of wires or other conductors heated (usually to incandescence) by the passage of an electric current through them. In some of the older forms, the heating element consists of large carbon filament lamps. In others it is formed by wires of nichrome or other alloy capable of withstanding prolonged heating without deterioration, mounted in fireclay supports. See also FIRE (ELECTRIC). Cf. CONVECTOR and RADIO-CONVECTOR.

Radiator, Electro-Vapour, and Hot Water. See ELECTRO-VAPOUR RADIATOR and HOT WATER RADIATOR.

Radiator Tube. See COOLIDGE RADIATOR TUBE.

Radio. An expression now used, chiefly to refer, either as a complete word or as a prefix, to all matters connected with what is otherwise called *Wireless Telegraphy* or *Telephony*, but also used in connection with the giving off of other kinds of rays. See RADIO-ACTIVITY, RADIOGRAPHY, etc.

Radio-Acoustic Position Finding. A subaqueous method of sound ranging in which a charge exploded under water is caused to close a "wireless" circuit, and the distance from the observing station is calculated from the time between the receipt of the sound of the explosion transmitted through the water. For application of a similar principle to sea sounding see ECHO DEPTH SOUNDER.

Radio-Active Constant. A constant for a particular substance or disintegration product upon which its rate of disintegration depends, being the value of γ in the equation $M_t = M_0 e^{-\gamma t}$, where M_0 is the original mass and M_t the mass t seconds afterwards.

Radio-Active Emanation. A gaseous

disintegration product of a radio-active material which produces a radio-active deposit upon solids exposed to it.

Radio-Active Materials. Materials such as radium which show the phenomena of *Radio-Activity*.

Radio-Activity. The phenomena of the giving out of energy by certain substances, such as radium, due to the detachment of electrons from and consequent successive internal re-arrangement of the atoms, causing the formation of a series of disintegration products. See METABOLON.

Radio-Beacon. A wireless transmitting station for sending out special signals by the help of which ships or aircraft can localise their positions.

Radio-Beacon, Course Indicating, Directive, Equi-signal, Omni, and Talking. SEE COURSE INDICATING RADIO-BEACON, DIRECTIVE RADIO-BEACON.

Radio-Communication. The transmission of signals by means of electric waves without conductive circuits between the sending and receiving stations. See WIRELESS TELEGRAPHY and WIRELESS TELEPHONY.

Radio-Compass. See WIRELESS DIRECTION FINDER.

Radio-Convactor. An electric heater for rooms, etc., in which the principles of the *Radiator* and the *Connector* are combined.

Radio-Engineering. The practical application of wireless telegraphy, telephony, etc., on a large scale.

Radio-Examination of Materials. See RADIO-MATERIALOLOGY.

Radio-Frequency. A frequency such as used for oscillations employed in wireless transmission, i.e. over 10,000 cycles per second, commonly spoken of in wireless as *High Frequency*. Cf. AUDIO-FREQUENCY.

Radio-Frequency Amplification. Amplification of wireless signals at the frequency of the received carrier wave before they are rectified by the detector, and not at the frequency of the modulations.

Radio-Frequency Transformer. A transformer for radio-frequency

circuits, such as a transformer for coupling high-frequency amplifier valves with an air cone.

Radio-Goniometer. An instrument forming part of a *Wireless Direction Finder*, consisting, in the Bellini-Tosi instrument, of two coils each connected to one of two aerial systems placed at right angles to each other. One of the coils in the instrument is fixed and the other can be turned into any angular position relatively to it, until the signals received by the two sections of the aerial exactly balance. The direction from which the signals come then corresponds to the angle between the two coils in the instrument. In another system the principle of the cathode ray oscillograph is employed, with two sets of deflecting plates at right angles.

Radiogram. (1) Popular term for a message received by *Wireless Telegraphy*. (2) See "X"-RAY PHOTOGRAPH. (3) Popular abbreviation for RADIO-GRAMOPHONE.

Radio-Gramophone. A combined electric gramophone and wireless receiving set.

Radiograph. A photograph taken by "X" Rays.

Radiographer. An expert in *X-Ray Photography* usually working under a *Radiologist*.

Radiography. Photography by means of "X" Rays or rays from *Radio-active materials*.

Radio-inductive Interference. Interference with wireless reception due to inductive effects at neighbouring power or communication circuits.

Radiologist. One who practises the medical and surgical applications of *X Rays*.

Radiology. The science and practice of the production and application of "X" Rays.

Radio-Materialology. The science and practice of the examination of materials by means of "X" Rays, e.g. the discovery of hidden cracks and flaws.

Radio-Metallography. The examination of the crystalline structure and other features of metals and alloys by means of "X" Rays.

Radiometer. Any instrument for the

measurement of radiation, originally limited to the *Crookes Radiometer* for the frequencies of radiant heat and light, consisting of a pivoted system carrying light vanes enclosed in a high vacuum. One side of each vane is blackened and its greater absorption causes a difference of mechanical pressure between the two sides of the vanes, resulting in rotation at a speed dependent upon the amount of radiation falling upon it.

Radiomicrometer. A very sensitive instrument for measuring radiation by allowing it to fall upon a thermojunction forming part of the moving system of, and connected to, the delicate moving coil of a galvanometer, which is deflected by the minute current due to the rise of temperature of the junction.

Radiophone, Radiophony, etc. See WIRELESS TELEPHONE.

Radiophote. A wireless form of the *Telephoto*.

Radiophotogram. A photograph transmitted by wireless *Photo-Telegraphy*.

Radiophotography. See RADIO-PHOTO-TELEGRAPHY.

Radio-photo-telegraphy. The wireless transmission of photographs. See PHOTO-TELEGRAPHY.

Radio-Range. An *Equi-signal Radio-Beacon* for dealing with several converging routes.

Radioscope. An apparatus for projecting home talking films by controlling the synchronisation of a home cinema with a gramophone at a broadcasting station by special signals.

Radiotelegraphy. See WIRELESS TELEGRAPHY.

Radiotelephone and Radiotelephony. See WIRELESS TELEPHONY.

Radio-Therapy. The science and practice of the curative application of "X" Rays and other radiations.

Radio-Transmission. The sending out of electric waves for wireless signalling, etc., or control.

Radio-Transmitters. See WIRELESS TRANSMITTER.

Radiotron. A name sometimes given to a *Thermionic Valve*, particularly when used as an oscillator.

Radiovision. Wireless *Television*.

Radiovisor. A name adopted for a relay worked by *Light Sensitive Cells* for such purposes as lighting and extinguishing lamps at dusk and dawn, automatically, burglar alarms and other purposes.

Rail: Conductor, Contact, Fourth, Live, Side-Contact, Third, Top-Contact, Under-Contact, Under-Running. See CONDUCTOR-RAIL, CONTACT-RAIL.

Rail-Bond. A conducting bond between lengths of conductor rail or track rail.

Rail-Bond, Chicago, and Plastic. See CHICAGO RAIL-BOND, and PLASTIC RAIL-BOND.

Rail-Bond Tester. A portable apparatus for indicating the resistance of a rail joint between two contact spikes, applied on either side thereof by a fall of potential method.

Rail-less System (of Traction). See TROLLEY-OMNIBUS.

Railway (Electric). A system on which trains, cars, etc., are propelled on a railed track by electric power.

Railway: Funicular, High Tension Direct Current, Rack, Single-Phase, Suspended, Three-Phase, Tube, and Underslung Monorail. See FUNICULAR RAILWAY, HIGH TENSION DIRECT CURRENT RAILWAY, etc.

Railway Generator, Railway Motor, etc. See TRACTION GENERATOR, etc.

Railway-Signalling (Electric). Railway signalling in which the signals are actuated or controlled wholly or partially by electrical means. See References under SIGNAL-LING.

Railway-Signalling, Automatic. See AUTOMATIC SIGNALLING.

Rail-Wheel Bond Tester. A direct reading instrument of the ohmmeter type, for indicating the resistance between the tyre of a wheel and its axle, for use where track-circuiting is practised.

Range (of Armature Windings). Windings are said to be One Range, Two Range, Three Range, etc., Windings when they have one, two, three, etc., rows of end connections behind one another owing to the way the conductors have to cross.

Range, Radio and Variation. See RADIO RANGE, and VARIATION RANGE.

Range Finder, Wireless. See WIRELESS DIRECTION FINDER.

Range Switch. See TUNING SWITCH.

Rank (Automatic Telephony). *Selectors*, etc., are said to be of the first, second, etc., "rank" according as they perform the first, second, etc., stage of selection.

Raphael Bridge. A form of slide-wire bridge for carrying out loop tests of circuits for localisation of faults; so arranged that the scale of the slide wire is graduated to read the distance of the fault directly in yards.

raphone. An experimental loud-speaking telephone receiver invented by Dolbear in 1879 in which the vibration of the diaphragm was controlled by variations in the friction between a revolving electromagnetic system, excited by the received current, and an iron finger rubbing thereon.

Rate : Discharge. See DISCHARGE RATE.

Rated Output, Voltage, Current, etc. The *Output, Voltage, etc.*, for which a machine or apparatus is designed to work under specified conditions.

Rating. The load which a machine or apparatus is designed to carry under specified conditions, which vary according to the kind of rating in question.

Rating : Continuous, Crane, Ignition, Intermittent, Load Factor, Normal, One Hour. See CONTINUOUS RATING, CRANE RATING, etc.

Ratio : Lay, Reflection, Shunt, Spacing, Stability, Tooth, Transmission, Transport, and Voltage. See LAY RATIO, REFLECTION RATIO, etc.

Ratio Arms. Two continuous arms of a Wheatstone's Bridge arranged so that the resistances of which they are composed can be varied to have any of several fixed ratios to each other. See PROPORTIONAL COILS.

Ratio-Balance Protective System. A protective system in which the time elements of the relays are controlled by the reactance between a combination and the fault, i.e., the distance away of the fault.

Ratio Error. A lack of constancy throughout their range of the proportionality between the primary and secondary voltages and currents in *Potential* and *Current Transformers* respectively; more serious in the case of the latter than the former. Cf. PHASE ERROR.

Ratio of Transformation. The ratio between the primary and secondary voltages of a transformer under no-load conditions, or, in the case of current transformers, between the primary and secondary currents. Usually approximately equal to the ratio of the number of turns in the primary to that in the secondary winding.

Ratio Test. Accurate measurement of *Ratio of Transformation*.

Ratiometer. (1) An instrument for carrying out *Ratio Tests* of transformers, in which the primary and secondary voltages are balanced by a resistance bridge arrangement. (2) An instrument of the moving coil type with one moving system of two coils arranged so that the deflection is proportional to the ratio of the currents in them, used in resistance thermometry, and for other purposes. In another type two fixed coils and a moving iron system are used. Also called QUOTIENT METER.

Rationalisation (of Units). The alteration of the "unrationalised" systems of electrical and magnetic units, so that unit magnetic pole and electric charge respectively should emit unit magnetic and electric flux instead of 4π units.

Rat-Tail. A wire, or collection of wires, connecting the main portion of an aerial with the *Leading-in Wire* to the apparatus.

Rattler. An instrument similar to a Buzzer, but arranged to give a different characteristic sound.

Ray (Electric). An aquatic animal (Rain Torpedo) capable of producing by physiological means electric discharges from a special organ in the back of its head. Cf. ELECTRIC EEL, etc.

Rays : Alpha, Becquerel, Beta, Canal, Cathode, Death, Delta, Diacathode, Direct, Discharge, Gamma, Grenz, Ground, Infra-Red, Lenard, Micro,

Positive, Röntgen, Secondary "X," Space, Ultra-Violet, Ultra "X," Uranium, Vita, and "X." See ALPHA RAYS, BECQUEREL RAYS, etc. See also references under RADIATION.

Rayleigh Cycles (of Magnetisation). Cycles of magnetisation, of which the maxima lie on the "initial" portion of the magnetisation curve between the zero and the upward bend. In this region the permeability is low and the action is without *Hysteresis*.

Ray-Locking Device (in Cathode-Ray Oscillographs). Electrostatic or other arrangements contained in a special chamber to deflect the electron jet away from the aperture in the diaphragm to prevent it affecting the photographic film before and after the events to be recorded.

Ray-Protected X-Ray Tube. An *X-Ray Tube* covered with material which prevents emission of *X-Rays* except through a special window.

Raytheon Valve. A form of gas-filled *Old Cathode Ionic Valve* used as a rectifier.

Reactance. The component of the *Impedance* of an alternating current circuit due to the effects of inductance and capacitance, i.e. the component in quadrature with the current. Equal to $2\pi fL - 1/(2\pi fC)$, where L , C , and f are the *Inductance*, *Capacitance*, and *Frequency*, respectively; measured like the other component of Impedance, i.e. resistance, in Ohms. Symbol: X .

Reactance: Capacitance, Earthing, Equivalent, Inductive, Magnetic, and Synchronous. See CAPACITANCE REACTANCE, EARTHING REACTANCE, etc.

Reactance Bond. See IMPEDANCE BOND.

Reactance Coil. A coil constructed to have considerable *Reactance*, i.e. a *Reactor*.

Reactance Dimmer. A *Dimmer* used for a.c. stage lighting circuits in which the reactance of a choking coil in series with the lamps is varied by altering the saturation of the core by an auxiliary coil carrying d.c.

Reactance Drop. That part of the voltage drop in a circuit due to *Reactance*.

Reactance Tie Bars. *Tie Bars* containing a reactance sufficient to limit the current that can be exchanged between two sections of a bus-bar system on short circuit to a safe value.

Reactance Voltage. The component of the voltage in a circuit used in overcoming the reactance, i.e. the vectorial product of the reactance and the current. The expression is used in the study of commutation with reference to armature coils at the moment when the current therein is undergoing commutation, and in alternator design for the component of the voltage due to reactance, including that due to *Armature Reaction*, *Leakage Flux*, etc.

Reaction (in Wireless Receiving Apparatus). See RETROACTION.

Reaction, Armature. See ARMATURE REACTION.

Reaction Alternator. A synchronous alternator depending for excitation upon an a.c. supply of correct frequency.

Reaction Brush Holder. A box-type brush holder in which the brushes are inclined against the direction of motion of the commutator so that the thrust due to the motion tends to tighten the brush in its box.

Reaction Circuit. See RETROACTIVE CIRCUIT.

Reaction Condenser. See RETROACTION CAPACITANCE.

Reaction Coil. See RETROACTION COIL.

Reaction Generator. See REACTION ALTERNATOR.

Reaction Oscillations. Oscillations, in a thermionic valve circuit, produced by feeding back from the anode to the grid circuit, as ordinarily produced in wireless transmission.

Reactive Ampere-hour Meter. A motor integrating *Reactive Current*.

Reactive Component. See REACTIVE CURRENT, VOLTAGE and VOLT-AMPERES.

Reactive Current. The component of an alternating current in quadrature with the voltage.

Reactive Drop. See REACTANCE DROP.

Reactive Factor. The ratio of the reactive volt-amperes to the total volt-amperes.

Reactive Iron. Iron added to the leakage paths, etc., of a transformer or choking coil in order purposely to increase its *Inductance*.

Reactive Load. A load in which the power factor is not unity, i.e. a lagging or leading load.

Reactive Power. See REACTIVE VOLT-AMPERES.

Reactive Power Meter. See REACTIVE VOLT-AMPERE-HOUR METER.

Reactive Voltage. The component of an alternating voltage in quadrature with the current.

Reactive Volt-ampere-hour Meter. A meter integrating *Reactive Power* ($EI \sin \phi$) instead of *Real Power* ($EI \cos \phi$); used with tariffs in which power factor is taken into account. (Also called *Sine Meter* and *Wattless Component Meter*.)

Reactive Volt-amperes (in an Alternating Current Circuit). The component of the volt-amperes (*Apparent Power*) not representing the work done in watts ($EI \sin \phi$). The product of the reactive current and the voltage. (Also sometimes called *Reactive Power* or *Wattless Power*.) This use of the word Power is open to criticism.

Reactor. An apparatus of considerable reactance inserted in a circuit for that reason.

Reactor, Current-Limiting and Synchronous. See CURRENT-LIMITING REACTOR and SYNCHRONOUS REACTOR.

Reading Condenser. A shunted condenser used in conjunction with a receiving telegraph instrument, particularly in *Duplex* working. Cf. SIGNALING CONDENSER.

Real Power (in an Alternating Current Circuit). The component of the volt-amperes (*Apparent Power*) representing the true work done, i.e. the volt-amperes multiplied by the power-factor ($EI \cos \phi$). Cf. REACTIVE VOLT-AMPERES.

Receiver. A complete apparatus for the reception of incoming elec-

trically transmitted messages, signals, etc. Used in telephony for the actual apparatus which is held to the ear.

Receiver: Bell, Bipolar, Check, Condenser, Crystal, Directional, Head, Magneto, One-Valve, Portable, Selective, Telegraph, Telephone, Television, Thermal, Three-Valve, Two-Valve, Unidirectional, Universal Mains, Valve, and Wireless. See BELL RECEIVER, BIPOLAR RECEIVER, etc. (See also references under RECEPTION.)

Receiving Circuit. The apparatus and connections of the equipment of a wireless telegraph or telephone station used exclusively for reception of messages. Cf. TRANSMITTING CIRCUIT.

Receiving Earth (in a Submarine Cable). A *Sea Earth* used for receiving purposes only usually at a point out at sea where the depth is over 500 ft. Cf. TRANSMITTING EARTH.

Receiving Perforator. An apparatus such as that used in the *Creed Printing Telegraph* system which automatically punches a paper strip according to the signals received, thus reproducing the strip which is being passed through the transmitting apparatus.

Receiving Station. (1) A station at the far end of a long power transmission line where the energy is utilised or whence it is distributed in a convenient form. (2) A station for the reception of wireless or other electrical signals or messages.

Receiving System, Diversity. See DIVERSITY RECEIVING SYSTEM.

Receptacle. A *Socket* into which a *Plug* is inserted to make electrical connections.

Reception: Autodyne, Auto-Heterodyne, Autoplex, Band-Pass, Beat, Cryptodyne, Crystadyne, Dictaphone, Diplex, Endodyne, Heterodyne, Homodyne, Hyperdyne, Infradyne, Isodyne, Multiple, Neutrodyne, Neutrosomic, Peridyne, Shock, Steriophonic, Strobodyne, Super-Retroactive, Super-Heterodyne, Supersonic Heterodyne, Supradyn, and Ultradyn. See AUTODYNE RECEPTION, AUTO-HETERODYNE RECEPTION, etc.

Recessed Switch. See **FLUSH SWITCH**.

Reciprocating Motor. A motor which produces a reciprocating movement, such as that used in some forms of rock drill, instead of the pure rotary movement more usual with electric motors.

Reciprocating Rock Drill (Electric). A form of electric rock drill in which the drill is caused to make a reciprocating movement, combined with a slow rotary feed by alternate attraction in opposite directions of a plunger in a solenoid or otherwise.

Recoil Loop. A loop formed in a *Demagnetisation Curve* by a temporary change in the magnetising force in the positive direction and back again to the original value.

Reconstructed Mica. See **MICANTITE**.

Recorder. (1) An instrument which automatically records on paper a telegraph message as it is received. (2) A *Graphic Instrument*.

Recorder: Averaging, Intermittent Contact, Lightning Stroke, Relay, Siphon, Spark, Surge, and Thread. See **AVERAGING RECORDER, INTERMITTENT CONTACT RECORDER**, etc.

Recording (Electric). The process of preparation of originals of gramophone records in which the sounds are first received by one or more microphones, similar to those used in broadcasting, the output of which, suitably amplified, works the electromagnetic tool which cuts the record. This system not only enables the cutting apparatus to be at some distance from where the sounds are produced, but has advantages over the older mechanical system in that it can deal with a much greater range of pitch and of volume, and gives greater purity of tone. See also **TELEGRAMPHONE**.

Recording Attachment (to a Gramophone). An appliance similar to a *Gramophone Pick-up*, but with a recording instead of a reproducing needle, mounted on an arm with mechanism giving an axial feed motion.

Recording Instrument. See **GRAPHIC INSTRUMENT**.

Recording Potentiometer. See **POTENTIOMETER**.

Recovery Voltage. The voltage across the terminals of a circuit-breaker, etc., after rupture of the arc is complete.

Rectification. The conversion of an alternating current into a unidirectional current. See **RECTIFIER** and **RECTIFIED CURRENT**.

Rectification: Anode, Anode Bend, Cumulative Grid, Full-Wave, Grid, Grid-Leak, One-Wave, Simple, Single-Wave, Two-Electrode, and Two-Wave. See **ANODE RECTIFICATION, ANODE-BEND RECTIFICATION**, etc. (See also references under **RECTIFIER**.)

Rectified Current. A current that has been converted from an alternating current into a unidirectional current, either by suppressing alternate waves, or by reversing their direction; with or without special means being taken to smooth out the pulsations.

Rectifier. An apparatus which converts an alternating current into a unidirectional current, without the use of dynamo electric machinery, including apparatus depending upon synchronously moving commutators and electrolytic and thermionic appliances, mercury vapour arcs and crystal contacts, etc., which conduct only, or more readily, in one direction. See also **VALVE**.

Rectifier: Aluminium, Arc, Barrier-Film, Colloid, Commutator, Cooper-Hewitt, Copper-Oxide, Cuprox, De-ion, Discharge Tube, Dry Plate, Electrolytic, Electronic, Ferranti, Graetz, Grid-Controlled, Inverted, Liquid Brush, Magnetron, Marx, Mechanical, Mercury-Arc, Mercury-Vapour, Metal, Metal Oxide, Natural, Neon Tube, Perfect, Pilot-Spark Arc, Rectigon, Snook, Thermionic, Tuned Reed, Tungar, Valve, and Vibrating Reed. See **ALUMINIUM RECTIFIER, ARC RECTIFIER**, etc. (See also references under **RECTIFICATION**.)

Rectifier Operated Instruments. Measuring instruments for alternating current consisting of instruments similar to those employed for direct current, used in conjunction with a rectifier of the *Metal* or other type.

Rectifier Photo-electric Cell. The class of *Photo-electric cells* of the *Photo-voltaic* type in which electrons pass from a semi-conducting to a conducting layer under influence of radiation. Also called *Barrier-Layer Cell*.

Rectifier System of Arc-Lighting. Lighting by arc-lamps supplied with unidirectional current, obtained by a rectifier from an alternating current circuit, in order to combine the advantages of alternating current transmission with the better efficiency of direct current arc-lamps.

Rectifying Detector. A detector of electric waves, i.e. a wireless receiver, such as a crystal or thermionic valve detector, which acts by rectifying the received oscillations so that they give an audible effect in a telephone receiver, due to the successive impulses from each *Carrier Wave* having a cumulative effect on the diaphragm instead of cancelling out.

Rectifying Valve. An electrolytic or thermionic valve used as a *Rectifier*.

Rectifying Valve, Hot Cathode Mercury Vapour. See HOT CATHODE MERCURY VAPOUR RECTIFYING VALVE.

Rectigon Rectifier. A rectifier of the Thermionic Valve type with tungsten filament cathode and graphite anode in an argon-filled bulb; used for battery charging from a.c. circuits.

Recuperator. A form of *Phase Advancer* proposed by Lablanc, in which a copper disc with suitable connections to the slip-rings of an induction motor is allowed to vibrate freely in a direct current field. Cf. KAPP VIBRATOR.

Recurrent Circuit. A circuit consisting of successive sections, each containing the same arrangement of resistance, inductance, and capacitance as used for *Artificial Lines* and some kinds of *Filters*. (Also called *Lattice Circuit*.)

Red Magnetism. An old-fashioned name for the lines of force at the North pole of a magnet. Cf. BLUE MAGNETISM.

Rediffusion (Wireless). See AUDIO-FREQUENCY REDIFFUSION.

Reducing Screen (in Photometry). A surface transmitting a known fraction of the luminous flux reaching it.

Reducing Surface (in Photometry). A surface reflecting a known fraction of the luminous flux reaching it.

Reduction Factor of the Mean Spherical Intensity. See SPHERICAL REDUCTION FACTOR.

Reed Frequency Meter. See VIBRATING-REED INSTRUMENTS.

Reed-Type Loud Speaker or Telephone. A *Loud Speaker* telephone receiver in which the variable pull of the magnetic system is not exerted directly upon the diaphragm, but acts upon a spring-mounted "reed" connected mechanically to a large diaphragm of non-magnetic material.

Re-entrant Winding. An armature winding is said to be singly, doubly, or triply re-entrant according whether it contains one, two, or three closed circuits each re-entrant upon itself, independently of whether such circuits follow round the armature once, twice, or three times before doing so. Some authors, however, use the term in a different sense, using the degree of re-entrancy to signify the number of times such a winding follows round before closing upon itself. See MULTIPLEX WINDING.

Reference Equivalent (of a Telephone Circuit). The quality of a circuit expressed in decibels or nepers indicating a comparison with an adjustable reference system.

Reference Standard. See SECONDARY STANDARD.

Refining (Electric). The preparation of pure metals from their ores, or production of other pure chemical products from crude materials electrolytically or in the electric furnace.

Reflecting Electrode. The tubular outer electrode in a *Micro-ray* oscillator tube corresponding in construction but not in function of an ordinary *Triode*. Cf. OSCILLATING ELECTRODE.

Reflecting Galvanometer, Magnetometer, etc. A galvanometer, magnetometer, etc., the moving system of which carries a mirror used to reflect a beam of light from a fixed lamp, provided with a suitable lens, on to a scale so that a clearly visible spot of light, with a sharp image of a fine wire (stretched in front of the lamp) is seen on the scale and is deflected when the mirror swings. This has the effect of a long weightless pointer and greatly magnifies the deflection. Another method of using such a galvanometer is by observation of the reflection in the mirror of the fixed scale through a telescope. (Also called *Mirror Galvanometer*, etc.)

Reflection (of Electric Waves). *Electric Waves* passing through the ether are reflected from plane surfaces of a material which they cannot penetrate in the same way that light is reflected. Electric waves propagated along wires are also reflected back in a similar way when they meet with a medium which they cannot penetrate or are partially reflected at points where there is a sudden change in the impedance, etc., of the medium.

Reflection : Coefficient of, and Selective. See COEFFICIENT OF REFLECTION and SELECTIVE REFLECTION.

Reflection Factor. The ratio of the luminous flux reflected by a surface to that incidental thereon. The flux reflected includes that specularly reflected (the ratio of which to the incident flux is called the *Regular (or Specular) Reflection Factor*), and the diffused flux (the ratio of which to the incident flux is called the *Diffuse Reflection Factor*). The Reflection Factor is also called *Total Reflection Factor*, *Reflection Ratio*, and *Coefficient of Reflection*. Symbol: p .

Reflection Losses. Losses in non-homogeneous telephone lines due to partial reflection of the waves of current where there are changes in the line characteristics. See COEFFICIENT OF REFLECTION and COEFFICIENT OF TRANSMISSION.

Reflection Ratio. See REFLECTION FACTOR.

Reflection Sounding. See ECHO DEPTH SOUNDING.

Reflector. A reflecting surface of suitable form used in conjunction with a lamp to direct the rays in a required direction with or without diffusion. Sometimes acting at the same time as a *shade*.

Reflector : Extensive, Intensive, and "X" Ray. See EXTENSIVE REFLECTOR, INTENSIVE REFLECTOR, etc.

Reflectoscope. A projector whereby an image of an opaque object upon which a powerful light from an arc or other lamp is concentrated, can be thrown upon a screen. Also called *Aphengescope*. See also EPIDIASCOPE.

Reflex Circuit. See DUAL AMPLIFICATION.

Reflex Voltmeter. A form of *Thermionic Voltmeter* in which the potential drop across the anode resistance is added to the *Grid Bias*.

Refraction (of Lines of Force). Change in direction of magnetic or electric lines of force when they pass from one medium to another of different permeability or specific inductive capacity respectively. Analogous to refraction of light.

Refrigeration (Electrical). Refrigeration, as carried out in domestic and other electrically worked plants under various trade names and in large industrial installations, is only electrical in so far as the ammonia or other compressors, brine-circulating pumps or fans for circulation of cooled air, etc., are driven by electric motors, or in cases of ammonia absorption apparatus, without moving parts, electric heating is employed at a certain part of the cycle of operations.

Regeneration. (1) *Retraction* in wireless receiving apparatus. (2) The reconditioning of exhausted apparatus as in a *Regenerative Cell*, or in the case of a *Thermionic Valve* by heating the filament for some hours without an anode voltage to bring the thorium or other active material to the surface.

Regenerative Arc-Lamp. An arc-lamp, such as the Jandus Enclosed Flame Arc-Lamp, in which the

gases pass into cooling tubes and back to the arc chamber over and over again.

Regenerative Brake. A system of braking on electric railways and tramways, cranes, hoists, etc., in which the motors are made to act as generators and return power into the line. This can be done automatically in the case of induction and shunt wound motors, without change in connections, as soon as a certain speed is exceeded, as in travelling downhill on mountain railways, and in a number of other cases by special motor windings and controller connections.

Regenerative Cell. A primary cell, the depolariser of which can be reactivated when exhausted, by a chemical or electrolytic method.

Regenerative Circuit. See RETRO-ACTIVE CIRCUIT.

Regenerative Control. A system of traction control in which *Regenerative Braking* is taken advantage of; applied more particularly to direct current systems.

Regenerative Receiver. See REGENERATIVE CIRCUIT.

Regenerative Repeater. A repeater for cable signals for converting signals of distorted wave form into sharp signals with flat wave form of the correct length, one variety of which consists of a form of commutator rotating synchronously with the signal elements.

Regenerator. See REGENERATIVE REPEATER.

Register. See TELEPHONE METER, and WESTERN ELECTRIC AUTOMATIC TELEPHONE SYSTEM.

Register Key and Register Rack. See METER KEY and METER RACK.

Registering Instruments. See INTEGRATING INSTRUMENTS (sometimes also used for *Graphic Instruments*).

Register Translator. See DIRECTOR.

Regular Reflection Factor. See REFLECTION FACTOR.

Regulating Cells. The cells at the end of a battery of accumulators which are individually connected to the contact of a *Regulating Switch* so that they can be cut in and out of circuit to regulate the voltage.

The term is sometimes applied to *Counter E.M.F. Cells*.

Regulating Resistance or Rheostat. A variable resistance used to regulate a current such as that in the field circuit of a dynamo or motor.

Regulating Switch. Any multiple contact switch used for regulating c.m.f., speed, voltage, etc.

Regulation. A general term for the measures taken to keep such quantities as voltage and speed within certain prescribed limits, or for the extent of the limits within which, in certain circumstances, they can be maintained or are allowed to be maintained.

Regulation: Hand, Inherent, Pressure, Speed, and Voltage. See HAND REGULATION, INHERENT REGULATION, etc.

Regulation Constant. The value of the *Kapp Coefficient* required to calculate the field necessary to obtain the full voltage at full load at specified power-factor.

Regulation "Down." The percentage drop in voltage given by a machine when the full load is suddenly thrown on, without variation in speed and excitation; more than the regulation "up."

Regulation "Up." The percentage rise in voltage given by a machine when the full load is suddenly thrown off, without variation in speed and excitation; less than the regulation "down."

Regulator: Automatic Voltage, Carbon, Controller, Field, Induction, Mercury Air Valve, Osmo-, Pilon, Potential, Shunt, Slip, Speed, Thury, Tirrill, and Voltage. See AUTOMATIC VOLTAGE REGULATOR, CARBON REGULATOR, etc.

Regulator Cell. See *Regulating Cell*.

Reguline. A smooth homogeneous electrolytic deposit.

Reinartz Circuit. An arrangement of wireless receiving sets, particularly for short waves, comprising an untuned aerial circuit coupled to a tuned secondary circuit connected to the grid of the detector valve, and containing a reaction coil. This can be combined with high or low frequency amplifying stages.

Rejector. An appliance on the

Chariot in a *Hughes Printing Telegraph* apparatus which ensures that a character is only printed on the first contact of the chariot with the projecting pin, and not again if the pin still projects during the next revolution of the chariot.

Rejector Circuit. A circuit containing a wave-filter, consisting of a combination of inductance and capacity in parallel for preventing the passage of currents of a certain frequency. Used in wireless telephony for tuning out stations not required, and in power circuits for removing harmonics liable to cause inductive interference. (Also called *Stopper Circuit*.) Cf. **ACCEPTOR CIRCUIT**. See also **WAVE TRAP**.

Relay. An electromagnet or other appliance which controls a circuit according to the changes of current in another circuit. The most common form consists essentially of an armature provided with contacts which are opened and closed by its movement under the influence of an electromagnet or solenoid.

Relay: Allström, Arc, Auto-, Brown (Submarine), Cable, Cable-Drum, Clearing, Compound-Wound, Cut-Off, Differential, Dipper, Directional, Discriminating, Distance, Diverter, Earth Leakage, Electronic, Frequency, Grid Glow, Gulstad, Impedance, Incrementer, Induction, Interlocking, Intermediate, Jockey, Light, Load-Levelling, Magnetic Drum, Maximum, Maximum Current, Maximum Voltage, Microphone, Minimum, Minimum Current, Minimum Voltage, Motograph, Neutral, Non-Polarised, No-Voltage, Over-Current, Over-Load, Over-Voltage, Phase-Balance, Piezo Electric, Pilot, Polarised, Protective, Reverse Current, Rotating Drum, Series, Shunt Field, Signal-Lamp, Solenoid, Submarine, Supervisory, Telegraph, Telephone, Thermal, Thermionic, Time-Delay, Time-Limit, Track, Translating, Transmitting, Trigger, Trip, Tuned, and Two Step. See **ALLSTRÖM RELAY**, **ARC RELAY**, etc.

Relay Automatic Telephone System. The latest form of the *Betulander*

system of automatic telephone exchange working in which electro-mechanical switches are entirely replaced by *Relays*.

Relay Contacts. Contacts closed by the movement of the armature of a relay.

Relay Dynamo. An expression used for a d.c. machine in which the armature current is proportional to the e.m.f. applied to the exciting circuit.

Relay Graphic Instruments. Graphic (i.e. *Recording*) instruments in which the movement of the pen is produced by a mechanical or electrical system controlled through or by the current to be measured.

Relay Magnet. An electromagnet forming part of a relay and causing the opening and closing of contacts by the movement of its armature.

Relay Rack. The frame in a telephone exchange on which are mounted rows of relays used for operating the signalling lamps and other apparatus.

Relay Recorder. See **RELAY GRAPHIC INSTRUMENTS**.

Relaying Sounder. An instrument similar to the ordinary *Morse Sounder*, but provided with contacts on its armature so that it can also be used as a *Relay*.

Release. (1) A device for causing a motor starter to return automatically to the "off" position, i.e. with all resistance in the circuit, on the occurrence of abnormal conditions or when tripped purposely by hand. Usually in the form of a *Holding-On Magnet* with its winding in series with a high resistance across the main voltage. If the current in this fails, a spring returns the lever to the starting position. The release can be tripped by hand, or by an overload or other relay, by shortcircuiting the winding of the holding-on magnet. (2) An electromagnetic mechanism for automatically opening a *Circuit-Breaker*. (3) A device for returning the switches on a telephone switchboard to the normal position on the termination of a call.

Release: Calling Party, First Party, Last Party, No-Voltage, Overload, Telephonist, and Under-Voltage.

See **CALLING PARTY RELEASE**, **FIRST PARTY RELEASE**, etc.

Release Wire. A wire controlling the release of automatic switches in telephony.

Reluctance. The property of a magnetic circuit or part of a magnetic circuit which resists the passage of magnetic flux through it; analogous to the *Resistance* of an electric circuit. Usually calculated separately for the different sections of the circuit, and in each case equal to $l/\mu s$, where l , s , and μ are the length, sectional area, and permeability respectively. The flux through the circuit is equal to the magnetomotive force divided by the reluctance. Symbol: S . Cf. **PERMEANCE**.

Reluctance: **Gap and Specific.** See **GAP RELUCTANCE** and **SPECIFIC RELUCTANCE**.

Reluctivity. The reciprocal of *Permeability*, i.e. the *Reluctance* of a material per centimetre cube.

Remanence. The portion of the magnetic flux density that remains through a magnet when the magnetising force is removed.

Remanence: **Apparent and True.** See **APPARENT REMANENCE** and **TRUE REMANENCE**.

Remote Control. The control of switchgear, etc., by electromagnetic, electropneumatic, mechanical, or other means from a point or points at a distance from the switches, etc., themselves. Partly for purposes of convenience and partly to avoid bringing connections for heavy currents or high voltages up to the operating positions of a switchboard.

Remote Control Switch. See **REMOTE CONTROL**.

Remote Metering. The registration on a meter at a central control point of the consumption of energy in a distant part of the system. See **TELEMETER**.

Remote Power Indicator. An instrument for indicating at a certain station the power flowing at a distant point on a network by pilot wires. One form is thermoelectric in its action.

Rennerfelt Furnace. A two-phase indirect arc furnace with two hori-

zontal electrodes and one vertical electrode directing the arc down on to the surface of the charge.

Renschler Ultra-Violet Light Meters. See **ULTRA-VIOLET LIGHT METER**.

Repeater. (1) Any apparatus by means of which the variations of current in one circuit are reproduced in another circuit in amplified form, including a relay used in long telegraph circuits for the purpose of increasing the working speed by subdividing the line into independent sections, the working speed of each of which is considerably better than that of the whole line. (2) A telephone *Repeating Coil*. (3) A *Thermionic Valve* used as a telephone *Relay*.

Repeater: **Cord Circuit, Discriminating Selector, Forked, Four-Wire, Impulse, Regenerative Selector, Telegraph, Telephone, and Two-Way.** See **CORD CIRCUIT REPEATER**, **DISCRIMINATING SELECTOR**, etc.

Repeater Gain. The increase in transmitting power, etc., due to a repeater expressed in decibels or nepers.

Repeater Station (Telephone, etc.). A station where incoming modulations are amplified by thermionic valves for transmission to a further length of land line. Extensively used both in trunk line telephony and in simultaneous broadcasting.

Repeating Coil. A *Transformer* or *Induction Coil* used to couple two parts of a telephone circuit inductively where a conductive connection is undesirable, as in cases of superposed telephone and telegraph working; usually of one-to-one ratio.

Repeating Relay. See **REPEATER**.

Repeating Selector. See **SELECTOR REPEATER**.

Repeating Sounder. See **RELAYING SOUNDER**.

Repeating Station. A telegraph station at an intermediate point in a long line where *Repeaters* are used.

Replenisher. A small electrostatic *Influence Machine* employed in *Quadrant Electrometers* to maintain the needle at a high potential; worked by a small milled head

which can be easily rotated with one finger.

Repulsion. The mechanical force tending to separate bodies of like electrical or magnetic polarity or neighbouring currents of opposite direction. Cf. *Attraction*.

Repulsion Motor. The class of alternating current commutator motor in which there is no conductive connection between the stator and rotor windings. In its simplest form, consisting of a field connected to a single-phase circuit and an armature with a commutator and short-circuited brushes set at an angle with the field.

Repulsion Motor : Compensated and Inverted. See COMPENSATED REPULSION MOTOR and INVERTED REPULSION MOTOR.

Re-Radiation. When a degree of retraction, just short of that producing self-oscillation, is used in a wireless receiving set, the signals received can be re-radiated from the aerial, sometimes enabling them to be picked up by neighbouring sets of low sensibility which could scarcely detect the direct signals.

Reserve Bus-Bars. An alternative *Bus-Bar* system which can be used instead of the ordinary bars for emergencies or during repairs or inspection.

Residual Charge. The portion of the charge of a condenser which remains after the condenser had been first discharged in the ordinary way, but not left short-circuited, and can produce a second discharge after a short interval, representing the energy of the *Anomalous Charging Current*. See SOAKING IN.

Residual Compensation. The arrangement of a protective system operated by *Distance Relays* so that the relays are actuated by a combination of leakage current and current in the earthed phase, in suitable proportions.

Residual Current (or Voltage). A term sometimes used in connection with *Interference* in telegraph and telephone lines for the component of the current (or voltage) in the disturbing circuit which is unbalanced, i.e. in which the algebraic

sum of the currents (or voltages) is not zero. Cf. BALANCED CURRENT.

Residual Field. A field due to the *Remanent Magnetism* in the field magnets of a dynamo, etc., after the excitation has been removed.

Residual Gases. The small amount of rarefied gas that remains in a vacuum tube even after high exhaustion, sufficient, however, to show characteristic effects of different gases.

Residual Magnetism. The portion of the magnetism remaining in a substance after the magnetising force has been removed, including that portion which, especially in the case of soft materials is easily removed by vibration, etc., and the *Subpermanent* and *Permanent magnetism* which then remains.

Residual Voltage. See RESIDUAL CURRENT.

Residue (Electric). See RESIDUAL CHARGE.

Residue Curve. A wave form curve representing only the harmonics in an a.m.f. or current wave; obtained by eliminating the fundamental wave.

Resinous Electricity. An old name for *Negative Electricity* because resinous bodies, such as sealing wax, become negatively electrified by friction. Cf. *Vitreous Electricity*.

Resistance. The property of a conductor which "resists" the flow of current when an electromotive force is applied to it, and causes its energy to be converted into heat. The resistance of a wire of given material is directly proportional to its length and inversely proportional to its cross-section, and also depends upon its temperature. See TEMPERATURE COEFFICIENT. The practical unit of resistance is the *Ohm*, which is 10^9 C.G.S. electromagnetic units, and is such that, in the case of steady currents, 1 volt produces a current of 1 ampere through it. See OHM'S LAW, references under OHM, B.A. UNIT, SIEMENS' UNIT, etc. Symbol: *R*.

Resistance : Aerial Radiation, Anode, Anode A.C., Anode D.C., Apparent, B.A. Unit of, Ballast, Brazil,

Brush, Buffer, Carbon, Dust, Charging, Contact, Critical, Dielectric, Differential, Dimming, Direct Current, Discharge, Earthing, Economy, Effective, Electrolytic, Equivalent, External, Field Discharge, Filament, Fixed, Graphite, Grid, High Frequency, Inductive, Insulation, Internal, Jacobi's Unit of, Lamp, Leakage, Liquid, Low Frequency, Magnetic, Negative, Non-Inductive, Ohmic, Preventive, Radiation, Ribbon, Shunt, Shunt Breaking, Shunt Regulating, Siemens' Unit of, Slide, Spark, Specific, Specific Magnetic, Spurious, Stabilising, Standard, Starting, Substitutional, Swamping, Temperature Coefficient of, True, Variable, Water-Cooled, and Weber's Unit of.

See AERIAL RADIATION, RESISTANCE, ANODE RESISTANCE, etc.

Resistance Alloys. See RESISTANCE MATERIALS.

Resistance Amplifier. See RESISTANCE COUPLED AMPLIFIER.

Resistance Box. A box containing a series of resistance coils connected to blocks on the top, arranged so that any coil or coils can be included in the circuit between the main terminals by the withdrawal of plugs which normally short circuit the individual coils. Sometimes simply arranged to form one variable resistance, and sometimes to contain three arms of a Wheatstone's Bridge, with the necessary keys and terminals. See POST OFFICE BRIDGE. In some patterns, multiple contact switches are used instead of plugs.

Resistance Bridge. See WHEATSTONE'S BRIDGE.

Resistance Capacitance Coupling. An arrangement to take the place of an intervalve transformer in which a high resistance (anode resistor) is connected in series with the plate of one valve and the differences of potential produced therein are applied through a grid condenser to the grid circuit of the next valve. In some cases a grid leak is employed to prevent the grid accumulating too high a negative charge. Less distortion is obtained than with transformers.

Resistance Coil. A coil of wire used

for the purpose of introducing resistance into a circuit.

Resistance Coupled Amplifier. A multivalve amplifier with resistance, or resistance capacity coupling, between the stages.

Resistance Coupling. *Coupling* two wireless circuits by a resistance common to both. See RHEODYNE CIRCUIT.

Resistance Drop. The drop of potential between two points on a conductor which is carrying a current, due to the resistance between them; equal to IR , where I and R are the current in amperes and the resistance in ohms respectively; usually expressed as a percentage of the voltage of the circuit. Cf. INDUCTIVE DROP.

Resistance Frame. A frame carrying a number of resistance coils, either connected permanently in series or otherwise to the terminals, or arranged so that any number may be included in the circuit by means of a multiple contact switch or otherwise for current regulation.

Resistance Furnace. An electric furnace in which the high temperature is obtained by passing a considerable current through a body of high resistance such as a carbon tube, or through the charge itself. Cf. ARC FURNACE.

Resistance Lamp. An incandescent lamp used as a resistor.

Resistance Losses. That portion of the energy losses in electrical machinery or apparatus due to heating of the conductors by the passage of current through them due to their resistance. See ' I^2R ' LOSSES.

Resistance Materials. Materials such as carbon or metals and alloys of high specific resistance used for the construction of resistances. See EUREKA, GERMAN SILVER, MANGANIN, NICHROME, PLATINOID, etc.

Resistance Notches or Positions. The positions on a controller at which resistances are included in the armature circuit. Cf. RUNNING NOTCHES.

Resistance Percussive Welding. A system of *Resistance Welding* in which hammer blows are given

simultaneously with or after a short burst of heating by a heavy current.

Resistance Pyrometer. A *Resistance Thermometer* for high temperature measurements.

Resistance Thermometer. An apparatus for measuring temperature by observing change in resistance of a platinum or other metallic wire exposed to the temperature to be measured, by a *Wheatstone's Bridge*, *Potentiometer*, or other system of resistance measurement, or by an instrument of the *Ohmmeter* class graduated to read direct in degrees.

Resistance Voltage. Alterm used in connection with a.c. for the vectorial product of resistance and current represented by the resistance drop.

Resistance Welding. Processes of electric welding in which the pieces to be welded are raised to the required temperature by passage of a heavy current through them while held in contact under mechanical pressure, e.g. *Butt Welding*, *Spot Welding*, and *Seam Welding*. Cf. ARC WELDING.

Resistance Wire. Wire for the construction of *Resistances*. See RESISTANCE MATERIALS.

Resistivity. The property of a material which determines the *Resistance* of a conductor made thereof, measured by the resistance per unit volume, mass, etc., of the material. Usual symbol: ρ (Greek "rho"). See below.

Resistivity: Mass, Surface, and Volume. See MASS RESISTIVITY, SURFACE RESISTIVITY, etc.

Resistor. A conductor of considerable resistance included in a circuit for that reason, i.e. a "resistance." See references under RESISTANCE.

Resistor, Heating. See HEATING RESISTOR.

Resistor Furnace. See RESISTANCE FURNACE.

Resonance. The condition of a circuit when the constants are such that free oscillations can take place as the same frequency as impressed by those which it receives.

Resonance, Selective. See SELECTIVE RESONANCE.

Resonance Amplifier. A low frequency amplifier with a tuned circuit which responds to the audio-frequency in question, thus obtaining very great selectivity and sensitivity. Suitable only for telegraphy where one note frequency is employed.

Resonance Constant. See OSCILLATION CONSTANT.

Resonance Curve. A curve showing the way in which the current induced in an oscillating circuit varies according to the frequency of the oscillations inducing it (other factors being equal); showing a sharp peak at the natural or resonating frequency of the circuit; the peak being sharper the smaller the *Decrement* of the circuit.

Resonance Frequency and Speed Indicators. See VIBRATING REED INSTRUMENTS.

Resonant Frequency. See RESONATING CIRCUIT.

Resonant Shunt. A device for guarding against interference with telegraph circuits, etc., by stray alternating currents, consisting of a shunt circuit containing inductance and capacity adjusted to give it the same natural frequency as that of the disturbing current placed in parallel with the apparatus to be protected, so as to draw off the disturbing alternating current without being affected by the signal current.

Resonating Circuit. A circuit having a natural period of oscillation at which it can resonate to a periodic stimulus, i.e. in which $4L$ is greater than R^2C , where L , R , and C are the inductance, resistance, and capacitance (in farads) respectively. The resonant frequency (Symbol: f_n) will then be $1/2\pi\sqrt{CL}$.

Resonator. Any device for detecting electric waves or oscillations by a method involving *Resonance*.

Resonator, Piezo-Electric. See PIEZO-ELECTRIC RESONATOR.

Responder. An early form of wireless detector used in the de Forest system, consisting of a tube containing *Lead Trees* which are broken up by the received oscilla-

tions, causing a sufficient alteration of resistance to produce a click in a telephone receiver.

Response Characteristic. A curve connecting input and output over a range of different frequencies for a piece of apparatus used in wireless reception or transmission.

Restriking Voltage. The high frequency transverse voltage that exists in a circuit-breaker and during the arc at the moment when the current value passes through zero.

Resultant Fault. The position which a single fault would have for its effect on the resistance between cable and earth, etc., to be equivalent to that of the existing faults, if more than one, and any distributed leakage that exists.

Resultant Flux. The actual flux produced by a combination of more than one separately produced magnetomotive force.

Retardation Coil. (1) A coil of high inductance used in telephone circuits where it is required to allow a direct or low frequency ringing current to pass, but to oppose the passage of a high frequency telephone current. (2) A closed secondary coil used for the purpose of affecting the phase of an alternating magnetic field.

Retardation Method. (1) Of measuring losses: A method of measuring the friction, windage, and iron losses in a machine, by driving it at a known speed, throwing off the power suddenly and taking observations of the rate at which the speed diminishes as it gradually comes to rest, with the brushes up and down and the field excited and non-excited. The moment of inertia of the armature must be known. (2) Of simultaneous telegraphy and telephony: The class of system in which a high inductance or *Retardation Coil* is relied on to prevent telephone currents passing through the telegraph instruments, with or without condensers in the telephone circuit to prevent passage of the telegraph currents.

Retardation Network. A combination of inductance and capacitance in a circuit with the object of causing a voltage wave impressed on one end to be received at the other after a certain time interval, but without distortion of waveform.

Retardation Valve. A form of *Thermionic Valve* in which the grid is maintained at a higher potential than the anode so that the latter becomes the controlling electrode, and large changes in grid current are produced by small anode voltage variations.

Retarder. See RETARDATION COIL.

Retentiveness. The property of certain magnetic materials of retaining magnetism after the magnetising force has been removed.

Retentivity. The measure of the flux density remaining in a piece of a particular magnetic material after a strong magnetising force, sufficient to magnetise it to saturation, has been removed. Sometimes expressed as a percentage of the saturation value.

Retroaction (in Wireless Receivers). The effect of coupling, intentional or otherwise, between the anode and grid circuits of a thermionic valve tending up to a certain point to magnification of the signals but if carried too far set up disturbing self-oscillations unless special precautions are taken. Also called *Reaction* and *Feeding Back*.

Retroaction Coil. An inductance coil used as an *inductive coupling* to produce *Retroaction*.

Retroactive Capacitance. A capacitor used as a *Capacitive Coupling* to produce *Retroaction*.

Retroactive Circuit. An arrangement of a wireless receiver to take advantage of *Retroaction* to obtain increased sensitivity. Also called a *Regenerative* or *Reaction* circuit.

Return: Common, Earth, Insulated and Track. See COMMON RETURN, EARTH RETURN, etc.

Return Circuit. The portion of a circuit by which the current may be said to return to the generator from the point where it has been

utilized; generally meaning an earth return or an earthed return circuit like that of a tramway system.

Return Current. The current through an earth or other return circuit.

Return Feeder. A feeder on a traction system which reinforces the conductivity of the return circuit to minimise stray currents through the earth, sometimes used in conjunction with a *Negative Booster*.

Return Shock. An old-fashioned term for a shock experienced by persons in the neighbourhood of a lightning flash, or other powerful discharge, due to the sudden re-arrangement of electric stresses in the neighbourhood.

Reversal, Demagnetisation by Continued and Villari. See DEMAGNETISATION BY CONTINUED REVERSALS AND VILLARI REVERSAL.

Reversal Curve. A *Magnetisation Curve* in which each point is determined by the ballistic method by reversal of the magnetising current and not by a step by step method, so that no hysteresis effect is shown.

Reversal of Current. The causing of a current in a circuit to flow in the opposite direction from that in which it has been flowing, either by a change in the direction of e.m.f., as in an armature coil passing from one field magnet pole to another, or by a change in connections by a reversing key, etc.

Reversal of Phase. In an alternating current reversal of the current takes place many times a second, so that the effect of reversing the connections is more usually spoken of as "reversal of phase." This amounts to a change of phase of 180° .

Reverse Brush Contacts. Laminated brush contacts in oil circuit-breakers arranged with the brushes sloping in such a direction that the so-called *Throw-off Force* increases their contact pressure.

Reverse Compound Winding. See DIFFERENTIAL COMPOUND WINDING.

Reverse Current Circuit-Breaker. A circuit-breaker arranged to open

on the flow of current of opposite direction or phase from that in the rest of the system, as in the case of a battery feeding back into its charging circuit on a failure or drop of the charging voltage, or current flowing back into a generating set or station running in parallel with others due to an accidental drop in the voltage of the set or station in question below that of the rest of the system. See DISCRIMINATING CIRCUIT-BREAKER.

Reverse Current Cut-Out. See REVERSE CURRENT CIRCUIT-BREAKER.

Reverse Current Relay. A relay put into action by a current in opposite direction or phase from that of the current in the main part of the system, such as one for tripping a reverse current CIRCUIT-BREAKER.

Reverse Grid Current. A *Grid Current* in a direction such that it flows out of the valve at the grid.

Reverse Power Relay. A *Protective Relay* on an alternating current system, which is put into action by the flow of power from the system back into the generator circuit to which it is connected, i.e. a more accurate description of what is sometimes spoken of as a "reverse current" relay for alternating current, as it depends on the phase relation between the current in the generator circuit and the voltage of the bus-bars. Also called a *Discriminating Relay*.

Reversed Coupling. The coupling of wireless circuits where the capacitive and inductive coupling effects act in opposite directions.

Reverser. A device for reversing the direction of current in any part of a circuit, more particularly the apparatus on an electric locomotive or motor coach which reverses the motor connections for travelling in the reverse direction.

Reversible Booster. A *Booster* set, controlled automatically or by hand, which provides an additional voltage in an accumulator circuit during charging and an opposing voltage during discharge, so that the whole battery can be kept

connected permanently to a constant potential system. Such a booster can be controlled not only by the voltage of the battery so as to charge it when the battery voltage drops, but also by the load, so that the battery discharges at times of heavy load to assist the generating plant, and is charged when the generating plant is otherwise lightly loaded. See DIFFERENTIAL BOOSTER, ENTZ BOOSTER, HIGHFIELD BOOSTER, LANOASHIRE BOOSTER, etc.

Reversible Cells. Cells acting as electrolytic cells when current is passed through them in one direction, producing a chemical change, which can themselves produce a current in the reverse direction while reverting to the original chemical state, i.e. *Secondary Cells* such as *Grove's Gas Battery* or ordinary *Accumulators*.

Reversible Motor. A motor in which the direction of rotation can be changed by an alteration of connections without (in the case of a direct current motor) any alteration to the brushgear.

Reversible Potentiometer Type Field Rheostat. See POTENTIOMETER TYPE FIELD RHEOSTAT.

Reversing Commutator. An old-fashioned term for any form of key or switch for altering connections so as to reverse the direction of a current in a part of a circuit; more particularly the pattern in which contacts forming the two halves of the surface of a cylinder rotate and interchange their position between two contact brushes. The term "commutator" always implies reversal, but has become almost exclusively specialised to refer to that part of a dynamo or motor which periodically reverses the armature coils with respect to the external circuit.

Reversing Controller. A controller which can reverse the direction of rotation of a motor as well as controlling its speed.

Reversing Field. A field generating an e.m.f. in the reverse direction from that which had existed in an armature coil, in order to hasten commutation; due either to the

position of the brushes or to a separate *Commutating Pole*.

Reversing Key. A simple appliance for reversing small currents, as in telegraphy and experimental work.

Reversing Poles. See COMMUTATING POLES.

Reversing Switch. A switch arranged to reverse the direction of the current in a part of a circuit.

Revertive Control. Control of selectors, etc., in automatic telephony by impulses originating in the selector itself when once started, counted by the control apparatus and automatically stopped when the movement is finished.

Revolution Indicator (Electric). An instrument for indicating the speed of engines, etc., or vehicles, ships and aircraft, usually similar to that described under *Magneto Speed Indicator*.

Revolving Arc Furnace. A form of arc furnace in which the arc is given a continual rotary movement by a magnetic field.

Revolving Armature Alternator. An alternator of the older type in which the field magnets are stationary and the armature revolves and carries slip rings from which the current is collected.

Revolving Field Alternator. An alternator of the type that is now most usual, in which the armature winding is on the stationary frame or *Stator* and the field system revolves, the slip rings being employed for the excitation only.

Rheo-. A prefix used in several practically obsolete electrical terms derived from the Greek *ῥέος*, meaning anything flowing, i.e. a current. Thus the term "Rheostat" (which is the only one with this prefix in common use now) signifies an apparatus for keeping a current constant, i.e. a variable resistance. The prefix "Rheo-" has thus become falsely identified with resistance, although originally it was only used to mean current. Examples of both uses are given below.

Rheochord. An early form of graduated slide wire resistance.

Rheodyne Circuit. A circuit for a *Thermionic Oscillator* in which

resistance coupling is used between the plate and grid circuits. Cf. ORTHODYNE and ANTIDYNE CIRCUITS.

Rheometer. An obsolete name for a *Galvanometer*.

Rheomicrophone. A word wrongly used for a microphone depending on variation of resistance.

Rheomotor. An obsolete name for a source of e.m.f.

Rheophore. An old-fashioned name for a connection or terminal.

Rheoscope. An obsolete name for a current indicator.

Rheostat. An adjustable resistance for current regulation; originally applied to forms in which the resistance wire was wound on the outside of a cylinder arranged to be rotated to bring any point along the wire in contact with a fixed contact. Now applied to any form of variable resistance.

Rheostat: Carbon, Continuous, Diverter Type, Enamel, Exciter-field, Field, Field Diverter, Filament, Immersed, Liquid, Regulating, Reversible, Shunt, Starting, Wheatstone's. See CARBON RHEOSTAT, CONTINUOUS RHEOSTAT, etc.

Rheostatic Brake. An electric tramway or railway brake, formed by allowing the motors to act as dynamos by short-circuiting them on to the starting rheostats, which can be used to regulate the braking effect, and to dissipate the energy in the form of heat. (Also sometimes called *Dynamic Brake*.) Cf. REGENERATIVE BRAKE and PLUGGING.

Rheostatic Braking Controller. A *Braking Controller* with positions for disconnecting the motor or motors from the line and applying a RHEOSTATIC BRAKE.

Rheostatic Control. Speed variation of a motor by variable resistance in the armature circuit in the case of a continuous current motor, and in the rotor circuit of an induction motor; in both cases involving waste of power when running at a reduced speed.

Rheostatic Controller. A *Controller* for effecting speed control of a motor by the introduction of a variable amount of resistance into

the circuit. See RHEOSTATIC CONTROL.

Rheostatic Loss. Energy loss due to heating of resistances.

Rheostatic Starter. A motor starter which inserts resistance into the armature circuit of a direct current motor, or the rotor circuit of an induction motor, at starting, and cuts it out progressively as the speed rises. (Rheostatic starters are rarely used in the stator circuits of induction motors.)

Rheotome. Old-fashioned name for *Interrupter*.

Rheotrope. Old-fashioned name for *Reversing Key* or *Switch*.

Rho (ρ) symbol for *Volume Resistivity* and *Reflection Factor* (for luminous flux).

Ribbon Coil. A flat coil wound of a single spiral of metal ribbon insulated between turns, but sometimes bare at the edges.

Ribbon Conductor. A conductor composed of flat ribbon, used where the greater cooling surface than that of a round wire of equal section is an advantage in cases of heavy current density, on account of the more convenient shaped coil that can be made in transformers and the better space factor possible, and in lightning conductors, on account of the less resistance that it offers than a round wire of equal section to very high frequency currents.

Ribbon Flash. The broadened appearance sometimes seen in a photograph of a lightning flash, due to the flash consisting of several discharges following one another over the same course, and shown side by side on the photograph owing to movement of the camera.

Ribbon Microphone. A form of *Electromagnetic Microphone* in which a thin fluted aluminium ribbon is caused to vibrate between the poles of an electromagnet.

Ribbon Resistance. A resistance made of metal ribbon, either coiled up into flat coils or bent to a zig-zag shape, with insulation between each bend and pressed into a solid and compact block.

Richardson Effect. The emission of electrons from a metal or other

cooled body raised to a high temperature.

Righi Oscillator. An oscillator in which the spark gap is between two metal spheres placed between two smaller spheres.

Right-Hand Rule. See FLEMING'S RULE.

Right-Hand Winding. See HAND (of an Armature Winding).

Right-Handed Machine. A direct current machine in which the direction of rotation of the armature is clockwise when viewed from the coupling or pulley end.

Rigid Catenary Suspension. A form of *Catenary Suspension* in which the contact line is a stiffened structure, although, as in other cases of catenary suspension, it is suspended at intervals from a bearer wire or cable.

Rigid Suspension (of a Traction Motor). Suspension of a traction motor on the truck or underframe of a car or locomotive so that no part of its weight is spring borne.

Rigid Truck. A car or locomotive truck with parallel axles entirely without freedom of angular movement relatively to the frame. Cf. ARTICULATED LOCOMOTIVE, etc.

Rigidity, Dielectric. See DIELECTRIC RIGIDITY.

Ring (of a Telephone Plug). The metal contact ring on a telephone plug between the *Tip* and the *Sleeve*.

Ring (Electric). See NOBILI'S RINGS.

Ring(s): Balancing, Bonding, Brush, Clamping, Collecting, Commutator, Damping, Equalising, End, Faraday's, Floating, Grading, Gramme, Guard, Mica "V," Nobili's, Rocker, Shade Carrier, Slip, "V." See BALANCING RINGS, BONDING RINGS, etc.

Ring Armature. A practically obsolete form of armature with a ring-shaped or hollow cylindrical core wound with wire passing over the surface and through the interior; only the former being active in producing the e.m.f. See GRAMME RING and PACINOTTI RING.

Ring Bus-Bars. *Bus-Bars* arranged to form a closed ring so that any one section may be disconnected without interfering with

the supply to the remainder, as any part can be fed from either direction.

Ring Filament. A filament mounted in ring form in a single supporting spider at right angles to the axis of the bulb, as in the smaller sizes of gas-filled lamps (giving a *Spherical Reduction Factor* of over unity).

Ring Magnet. A closed ring of iron, etc., wound with an exciting winding traversed evenly by the magnet flux when excited, without exhibiting *Poles*.

Ring Main. A series of feeders arranged to form a closed ring so that any one section may be disconnected without the supply to the remainder being interrupted, as any part can be fed from either direction.

Ring Method (of Magnetic Testing). A *Ballistic Method* of magnetic testing in which the specimen is a closed ring (usually built up of stampings) of known cross section, upon which are wound a primary or magnetising winding in which a known current is suddenly reversed or altered in value, and a secondary or search coil connected to a ballistic galvanometer. (Also known as *Rowland's Method*.)

Ring Winding. See RING ARMATURE.

Ring Wire (in Telephony). See "R" WIRE.

Ringer. A bell used to call attention of a telephone subscriber; sometimes also used to signify a magneto or other generator used to supply the current for ringing such a bell.

Ringer, Magneto. See MAGNETO RINGER.

Ring(s): Automatic, Battery, Code, Harmonic, Interrupted, Keyless, Machine, Magneto, Manual, Party, Line, Power, and Selective. See AUTOMATIC RINGING, BATTERY RINGING, etc.

Ring(s) Battery. A battery used for supplying current for ringing telephone bells, usually only in small independent installations.

Ring(s) Current. The current which rings a telephone bell as distinguished from the audio-frequency

Speaking Current which actuates the receiver. Telephone circuits are arranged so that the ringing current is prevented from passing in some portions of the circuit which can be traversed by the speaking current, and vice versa, by means of condensers and inductances.

Ringin^g Dynamotor. A ringing generator combined as one machine with the motor that drives it.

Ringin^g Generator. A generator in a telephone exchange for supplying low frequency alternating current for actuating bells throughout the system.

Ringin^g Interrupter. A revolving contact maker, usually on the same shaft as a ringing generator set, employed to break up the ringing current into intermittent signals.

Ringin^g Key. A key at an operator's position of a telephone exchange switchboard for closing the circuit that sends a ringing current into a subscriber's line. Cf. **SPEAKING KEY**.

Ringin^g Key, Party Line. See **PARTY LINE RINGIN^g KEY**.

Ringin^g Tone (in Automatic Telephony). A signal heard in the receiver after *Dialling* is completed consisting of an intermittent low note with alternate long and short intervals signifying that connection has been made with the required line which is being rung.

Ripple Factor (of a Rectified Current). The ratio of the r.m.s. value of the ripple to the arithmetic mean value of the total current multiplied by $\sqrt{2}$.

Ripples. Small periodic variations of current or c.m.f. superposed upon the main current or e.m.f., and of higher frequency than the main alternations in the case of alternating currents.

Ripples: Commutator, Slot, and Tooth. See **COMMUTATOR RIPPLES, SLOT RIPPLES, etc.**

Rise and Fall Pendant. A pendant which can be pushed up and down so as to remain at any height, the surplus cord being absorbed by a pulley and counterweight or a spring drum arrangement.

Rise: Inductive, Temperature, and

Voltage. See **INDUCTIVE RISE, TEMPERATURE RISE, etc.**

Riser. (1) *Commutator Riser.* (2) *Rising Main.*

Rising Characteristic. A *Characteristic Curve* of a generator, etc., which shows that the voltage rises as the current increases, as in the case of an *Overcompounded* machine (or a series machine).

Rising Mains. Wires in an installation connecting the service with *Distribution Boards* above one another on different floors of a building.

Ritchie Photometer. See **WEDGE PHOTOMETER**.

R.M.S. Abbreviation for *Root Mean Square*.

Robinson's Direction Finder. A *Wireless Direction Finder* in which the aerial consists of two frame coils at right angles and rotatable as a whole. After a rough adjustment, using one coil, the final direction is found by adjusting till reversal of one coil does not alter the strength of the receiving signal. In a development of the system a galvanometer replaces the receiving telephone, and the reversal is accomplished by a motor-driven commutator so that the galvanometer reads zero when a balance is obtained. See also **AUTOMATIC DIRECTION FINDER**.

Rock, Magnetic. See **MAGNETIC ROCK**.

Rock Drill (Electric). Electrically driven drills for boring holes in rocks, etc., for the reception of explosive charges in tunnelling, mining, etc.

Rock Drill: Electro-Pneumatic, Percussive and Reciprocating. See **ELECTRO-PNEUMATIC ROCK DRILL, PERCUSSIVE ROCK DRILL, etc.**

Rocker, Brush. See **BRUSH ROCKER**.

Rocker Arm. See **BRUSH ARM**.

Rocker Ring. See **BRUSH RING**.

Rocky Point Effect. See **FLASH ARC**.

Rod, Lightning. See **LIGHTNING ROD**.

Rod Collector. A current collector for electric railways with overhead contact line, formed by a slightly curved metal bar with a spring hinged support at one end, allowing it considerable freedom of angular movement so that it can still make

contact with the line, whether the latter is in the centre of the track or considerably displaced therefrom.

Roehling-Rodenhauser Furnace. An *Induction Furnace* for steel manufacture.

Roget's Dancing "Spiral." An old-fashioned piece of experimental apparatus consisting of a helix of springy wire fixed at the top and allowed to hang down vertically, with the lower end dipping into a trough of mercury. When a current is passed through the wire, the attraction of the parallel turns causes the helix to contract, so that the lower end lifts itself out of the mercury and breaks the circuit. It then falls and re-establishes the current, acting thus over and over again as an automatic contact breaker or interrupter, with a period depending on the period of oscillation of the spring.

Roll Heater, Inductive. See *INDUCTIVE ROLL HEATER*.

Rolling Mill Drive (Electric). Non-reversing rolling mills are driven by constant speed motors directly coupled or geared to the rolls. In the case of reversing mills, especially those of large size, arrangements for speed control and power equalisation similar to those employed in electric *Winders* for mines are sometimes used, including direct current mill motors controlled by the *Ward Leonard System*, through a motor generator, with or without fly-wheel storage; or three-phase mill motors with automatic *Slip Regulators*.

Röntgen. The name of the International unit of "*X*" Ray quantity as measured by ionisation effect and designed as that quantity which, under specified conditions, produces in one c.c. of air such conductivity that one electrostatic unit of charge is measured at saturation current. See also *SOLOMON'S UNIT*.

Röntgen Rays, Tube, etc. See "*X*" RAYS, "*X*" RAY TUBE, etc.

Röntgenogram. See "*X*"-RAY PHOTOGRAPH.

Röntgenology. See *RADIOLOGY*.

Röntgenoscope. See *FLUOROSCOPE*.

Root Mean Square (R.M.S.) Value.

The value of the square root of the mean value of the square of an alternating current or voltage or other periodic current, being the value that a continuous current would have to be equivalent in heating effect, etc. Also called *Effective* or *Virtual Value*; in the case of a true sine wave, $1/\sqrt{2}$ of the maximum value.

Rope (Lift) Control. Control of an electric lift by means of a rope passing through the car, which can be pulled up or down by a person in the car to actuate the controller at the top or bottom of the shaft. Cf. *CAR SWITCH CONTROL* and *PUSH BUTTON CONTROL*.

Rose, Ceiling. See *CEILING ROSE*.

Rotary. A colloquial abbreviation of *Rotary Converter*.

Rotary Automatic Telephone System.

An automatic telephone system, such as that of *Lorimer* and one form of *Western Electric* system, in which the main members have a continuous rotary motion instead of a step by step action. Cf. *STEP BY STEP AUTOMATIC TELEPHONE SYSTEM*.

Rotary Condenser. A name sometimes given to synchronous motors when used for the improvement of power-factor, owing to their effect in advancing the phase of the current being similar to that of a condenser.

Rotary Converter. A machine for converting alternating into direct current (and vice versa), built on the lines of a multipolar dynamo with the addition of slip rings connected to suitable points in the armature winding by which the alternating current is supplied. Such machines have to be started by special means (e.g. by a separate motor, by a supply of direct current to the brushes on the commutator side, or from the a.c. side as inverted induction motors), and brought up to synchronism before they can be connected to the a.c. bus-bars, and unless special methods are employed, cannot vary the d.c. voltage

independently of the a.c. voltage. They are extensively used, with suitable transformers, in substations to form the connecting link between high tension transmission systems, and direct current distribution for traction.

Rotary Converter: *Inverted, Self-Starting, and Split Pole.* See *INVERTED ROTARY CONVERTER, SELF-STARTING ROTARY CONVERTER*, etc.

Rotary Current. A term occasionally found for a *Polyphase Current*.

Rotary Discharger. See *DISC DISCHARGER*.

Rotary Field. A magnetic field the direction of which rotates in space with or without rotation of the magnetic circuit and windings producing it, e.g. that produced by the stator of an induction motor supplied with polyphase currents.

Rotary Harmonic Absorber. A *Harmonic Absorber* in the form of a *synchronous* motor running at a speed corresponding to synchronism at the frequency of the harmonic to be absorbed.

Rotary Hysteresis. Hysteresis produced in iron, etc., by a rotary field and not one which simply reverses its direction; less than the latter, especially at high inductions.

Rotary Magnetism. See *ROTARY FIELD*.

Rotary Phase Advancer. A *Phase Advancer* with a rotating armature, e.g. the *Walker and Scherbius Phase Advancers*. Cf. *VIBRATORY PHASE ADVANCER*.

Rotary Phase Converter. See *PHASE CONVERTER*.

Rotary Spark Gap. A spark gap in a wireless transmitting apparatus in which the sparks take place between fixed electrodes and studs on a rotating disc, e.g. the *Disc Discharger*.

Rotary Switch. A *Branch Switch* opened and closed by rotating the handle in the same direction.

Rotary Synchroscope. An instrument on the principle of the *Phase Indicator* with two windings, to which an alternator to be synchronised and the bus-bars are connected respectively. The pointer rotates slowly in one direction when the incoming machine is running too slowly, and in the

other when it is running too fast, but is stationary when the speeds are equal and the incoming machine is in phase.

Rotary Transformer. A machine with rotating armature used for the transformation of direct current from one voltage to another. See *CONVERTER*.

Rotary Voltmeter. See *GENERATING ELECTROSTATIC VOLTMETER*.

Rotating Beacon Transmitter. See *ROTATING WIRELESS BEACON*.

Rotating Drum Relay. A form of relay in which the secondary contact is closed by the motion of a system the friction between which and a rotating drum is increased by the action of the primary current by *Magnetic* or *Electrostatic Adhesion*.

Rotating Field. See *ROTARY FIELD*.

Rotating Field Magnet. The field system of a *Revolving Field Alternator* or other machine in which the field magnet revolves and the armature is stationary.

Rotating Loop Radio-Transmitter. The name usually given to a particular form of *Rotating Wireless Beacon*, with a rotating loop aerial, used for aircraft to obtain their own bearings by taking the time that elapses between the reception of a non-directional signal coinciding with the North position of the "Beam" and the directional signal of the beam itself.

Rotating Magnetic Field. See *ROTARY FIELD*.

Rotating Wireless Beacon. An apparatus producing a *Wireless Beam* which rotates in a horizontal plane at a constant speed, giving out different signals in different directions, so that ships and aircraft can ascertain their bearings without directional receiving apparatus. For another system see *ROTATING LOOP RADIO-TRANSMITTER*.

Rotations: *Arago's*, and *Magneto-Optical*. See *ARAGO'S ROTATIONS* and *MAGNETO-OPTICAL ROTATIONS*.

Rotatory Converter, etc. A form of the more usual "Rotary" converter, etc., preferred by some writers on etymological grounds.

Rotor. The revolving part of a generator or motor, more especially

of a machine such as an induction motor, in which the revolving portion cannot be described correctly as an armature or a field system. Cf. STATOR.

Rotor: Cylindrical, Short-Circuited, Squirrel Cage, Slip-Ring, Three-Phase, and Wound. See CYLINDRICAL ROTOR. SHORT-CIRCUITED ROTOR, etc.

Rotor Core. The whole mass of laminations clamped together which form the magnetic circuit of the rotor and carry the windings, usually in slots or tunnels.

Rotor Starter. A starter for *Induction Motors* which gradually cuts out resistance in the rotor circuit.

Roundabout Method (of charging accumulators). A charging system in which a rotating switch arm makes contact with each cell in turn for charging, so that the voltage across the whole battery is not appreciably altered during charging.

Round-Sykes Magnetophone. A form of *Electromagnetic Microphone* in which a light flat coil, acting as a diaphragm, is supported in the field of a strong cylindrical electro-magnet. The changes of c.m.f. induced in the coil by movement are strongly amplified.

Routiner, Automatic. See AUTOMATIC ROUTINER.

Rowland's Method. See RING METHOD (of Magnetic Testing).

Rubber Cable. A cable in which the principal insulation is composed of india-rubber. Used more for interior wiring than for underground cables. The outer layers of rubber are more highly vulcanised than the inner, which is sometimes of pure rubber. When vulcanised rubber is in contact with the copper, the latter is usually tinned to protect it from the chemical action of the sulphur added during vulcanisation. A protective braiding or other covering is usually applied overall.

Rubber Tape. An adhesive insulating tape used for covering joints, etc., treated with almost pure rubber with a sticky surface.

Rubbing Contact. Contact between two surfaces in a switch, etc.,

which rub together when the switch is being opened or closed, and are thus self-cleaning.

Ruhmkorff Coil. The ordinary form of *Induction Coil* with trembler and condenser.

Rumford Photometer. See SHADOW PHOTOMETER.

Run Up. A dynamo is said to "run up" as its voltage gradually rises after starting up, while the field gradually builds itself up.

Running: Continuous, Discontinuous, Intermittent, Parallel, Shunt. See CONTINUOUS RUNNING, DISCONTINUOUS RUNNING, etc.

Running Coupler. An extra piece of screw conduit tube with a coupler for connecting to a length of tube which cannot conveniently be rotated.

Running Current: The normal current which a machine takes when running at its rated load; as opposed, in the case of a motor, to the *Starting Current*.

Running Light. A machine is said to be "running light" when at full voltage, if a generator, or at full speed, if a motor, without useful load.

Running Notches. The positions of a traction controller where there is no resistance in circuit, i.e. in a series-parallel controller, the *Full Series* and *Full Parallel Positions*. Cf. RESISTANCE NOTCHES.

Running Position. A running notch of a traction controller or the position of the handle of a starter or starting switch in which the connections for normal running are made. Cf. STARTING POSITION.

Running Voltage. The voltage applied to the terminals of a motor when running on load in cases where a different voltage is used at starting.

Rupturing Capacity. The maximum current or power which can be broken by a switch, circuit-breaker, etc., under specified conditions.

Rutherford Atom. See ATOM and NUCLEAR THEORY.

"R" Wire. The wire in a telephone circuit within the exchange connected to the *Ring* of the plug and to the "B" wire of the line. (Also called *Ring Wire*.)

“S”]

“S.” Symbol for *Reluctance*.

Safety-Device, Partridge. See PART-
RIDGE SAFETY DEVICE.

Safety-Fuse. See FUSE.

Safety-Gap. See PROTECTIVE SPARK
GAP.

Sag (of an Overhead Line). The vertical distance of the lowest point of a span of wire below the mean height of the supports at the two ends; depending on the initial tension at which the line was erected, the temperature, the span, and the material of which the conductor is made.

Saint Elmo's Fire. A visible discharge seen sometimes on metal points, ships' masts, etc., when there is a considerable atmospheric difference of potential, due to concentration of the potential at the points of conductors. See POINT EFFECT.

Salient Pole Generator. A generator with *Salient Poles*; used particularly in the case of revolving field turbo-alternators, to distinguish from the form in which a rotor has a cylindrical core with the winding embedded in slots.

Salient Poles. Poles in the field system of a generator, etc., consisting of separate radial projections each with its own pole piece, and usually with its own field coil.

Salt Bath Furnace. A type of small electric furnace for tool hardening, etc., in which the objects to be heated are immersed in a bath of fused salt, through which the heating current flows by suitable electrodes. The salt is only conductive at high temperatures, and auxiliary heating arrangements are required for starting.

Satellite Electrons. See NUCLEAR THEORY AND PROTON.

Saturation. The magnetic condition of a body of iron, etc., when an increase in the *Magnetising Force* (H) produced practically no change

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in the *Intensity of Magnetisation* (J), and therefore only the relatively slight change in the *Flux Density* (B) proportional to the change in the magnetising force, so that the portion of the magnetisation curve above the saturation point is nearly a straight line of very small slope.

Saturation Current. The value of the current through an ionised gas at which a change in the applied voltage, between certain limits, causes no change in the current; being that where all the available ionic carriers are employed. Further increase in the voltage above these limits can, however, cause a rise in the current above this saturation value owing to the ionisation of fresh molecules by collision.

Saturation Curve. A name by which a magnetisation curve of iron, etc., is sometimes known.

Saturation Factor. The ratio of the increase of excitation in a machine to the increase of voltage it produces, at the normal or any other voltage.

Saturation Value. The value of the flux density in a particular sample of magnetic material beyond which it cannot be appreciably increased by an increase in the magnetising force.

Sausage Aerial. See CAGE AERIAL.

Sayers Winding. A form of armature winding designed to prevent sparking by assisting the commutation by means of additional coils under the influence of an auxiliary pole.

S.B.C. Lamp Cap. See SMALL BAYONET CAP.

Scanning. The method adopted in *Television* transmitters to explore optically all parts of the object in succession, and in television receivers to build up the image by directing the rays illuminating it to all parts of the screen in succession,

in synchronism with the scanning of the object by the transmitter.

Scanning, Interlaced, Progressive, Spot Light, and Variable Speed. See INTERLACED SCANNING, PROGRESSIVE SCANNING, etc.

Scanning Line. The series of signal values throughout one transfer across the picture during *Scanning* in *Television*.

Scarfed Joint. A joint between portions of a conductor in a cable, etc., in which the ends are bevelled off so as to fit together and preserve a cylindrical shape without increase of diameter over the joint, when soldered together.

Scattered "X" Rays. "X" Rays which have become deviated by passage through a substance, sometimes with increase of wavelength. Cf. SECONDARY "X" RAYS.

S.C.C. Lamp Cap. See SMALL CENTRAL CONTACT CAP.

S.C.E. See STANDARD CABLE EQUIVALENT.

Schanshieff Cell. A single fluid zinc-carbon cell with an electrolyte of mercurous sulphate.

Scherbius (Motor) Control. An economical method of obtaining speed variation in an induction motor used in rolling mill drive, etc., by connecting to the slip rings a three-phase commutator motor which drives an induction or a synchronous generator, and thereby returns to the line the energy which would otherwise be wasted in rotor resistances. Regulation is effected on the excitation of the commutator motor, which is derived partly from a separate exciter. The system can be extended to speeds above synchronism by increasing the excitation of the commutator machine, which then acts as a generator driven by the induction motor and draws extra power from the line for supply to the main motor; in this case, a small frequency converting machine geared to the main motor is used in connection with the exciter. Cf. KRÄMER SYSTEM.

Scherbius Phase Advancer. A *Phase Advancer* for connecting to the slip rings of an Induction Motor, consisting of an armature with a

commutator and three brushes mounted on the main motor shaft without a separate stator, but with the iron extended radially outside the conductor, forming a magnetic circuit without an air gap.

Schering Bridge. A *Wheatstone's Bridge* arranged for comparing capacitances or measuring the power factor of a capacitor by comparison with a standard capacitor, the other two bridge arms containing respectively a variable resistance and a resistor shunted by a variable capacitance.

Schoenherr Furnace. A form of arc furnace for the *Fixation of Nitrogen* in which, at 4,000 volts, an arc 16 ft. long is maintained in a vertical tube fed with preheated steam at the bottom and water-cooled at the top.

Schottky Effect. See SHOT EFFECT.

Schweigger's Multiplier. An old-fashioned name for a multirun coil for a galvanometer, as it "multiplies" the effect of a single turn.

Scintillations. The name usually given to the little flashes of light produced by the impact of alpha particles on a phosphorescent screen, of a substance such as zinc sulphide.

Scissors Type Brush-Holder. A form of brush-holder used particularly for slip-rings, where the brush is held between jaws mounted on crossed pivoted arms, with a spring connecting the portions away from the brush.

Scott Connection. An arrangement of connections of transformers for converting from two or three phase or vice versa. The three-phase windings are T-connected, and the two unconnected coils of the two-phase side are on the same cores as the two three-phase coils forming the top of the T and that forming the upright part respectively; in the case where this is done with two transformers, one, forming the top of the T, is called the main transformer and the other connected to its middle joint (or the three-phase side) is called the *Teaser Transformer*.

Scrambler Circuit. A system of obtaining secrecy in wireless

telephony in which the speech band is divided into several ranges by filters and the frequency of each displaced by a modulator and demodulated so that the bands are interchanged before transmission and replaced again to form intelligible speech in the receiving apparatus. Cf. **SPEECH INVERTER**.

Scratch Filter. A *Wave Filter* used in conjunction with a *Gramophone Attachment* or *Pick-up* to silence "needle scratch" by suppressing oscillations of the corresponding audio-frequency.

Screen (in a Cathode Ray Tube). A chemically treated surface which shows luminosity at the point where the electron beam impinges upon it; used in *Cathode Ray Oscillographs* and *Television Receivers*.

Screen: Earth, Fluorescent, Insulating, Intensifying, Magnetic, and Reducing. See **EARTH SCREEN**, **FLUORESCENT SCREEN**, etc.

Screened Aerial. An aerial provided with a screen of parallel wires between it and the earth, acting as a counterpoise and to intercept the lines of force from the aerial to earth and to carry the return current, so as to eliminate a large fraction of the earth losses.

Screened Cable. A cable in which each conductor has a screen of copper tape wound over its insulation to protect it against inductive effects of neighbouring cores. See **SCREENING EFFECT**.

Screened Conductor. See **SCREENED CABLE**.

Screened Down Lead. A lead from an elevated wireless receiving aerial surrounded by a metal sheath to minimise effects of local interference.

Screened Pentode. A *Screened Valve* for high frequency amplification with an additional auxiliary grid between the screen grid and the anode at a suitable potential for eliminating the negative reactance slope in the characteristic and enabling the valve to handle a larger voltage swing with higher amplification factor.

Screened Plate Valve. See **SCREENED VALVE**.

Screened Valve. A *Thermionic Valve* with an additional grid, called a *Screen Grid*, maintained at a positive potential less than that of the anode, which has the effect of almost completely neutralising the capacitance between the control grid and the plate in order to avoid self-oscillation.

Screen Grid and Screen Grid Valve. See **SCREENED VALVE**.

Screening Effect. A metal sheet between two coils or conductors has the effect of screening one from the inductive action of the other, owing to the eddy currents set up in it counteracting the flux that would traverse the second. Similarly, the enclosure of apparatus in a copper box has the effect of protecting it from external influences. See also **MAGNETIC SCREEN**.

Screening Reactor. See **LINE CHOKING COIL**.

Screening Wires. Wires placed between transmission lines and communication circuits to afford protection of the latter from interference.

Screen-Protected Motor. A protected type motor with the openings covered with perforated metal covers with apertures from 1/30 to 1/2 in. in diameter.

Screw Plug Cartridge Fuse. A form of *Cartridge Fuse* or *Plug Fuse* with contacts similar to those of an *Edison Screw Lamp Cap*.

Screwed Conduit or Tubing. Conduit tube for interior wiring, etc., in which the joints are made by screwing one section into another. Cf. **SLIP CONDUIT**.

Screwed Coupler or Screwed Socket. A threaded *Coupler* for *Screwed Conduit* tube.

Screwed Tubing. See **SCREWED CONDUIT**.

Screws, Binding. See **BINDING SCREWS**.

Scrutineer, Automatic. See **AUTOMATIC SCRUTINEER**.

Sea Earth (in a Submarine Cable). The connection to the sheathing, through an earthing core of characteristics matched to the cable itself at a point in deep water. Adopted in preference to a local

land earth to minimise the effect of parasitic c.m.f.'s.

Sea Earth, Balanced. See BALANCED SEA EARTH.

Seal (in an incandescent Lamp). The point where the leading-in wires enter the bulb.

Sealed End. A hermetically sealed end of a lead-covered cable.

Sealed-in Batteries. Accumulator batteries composed of cells in closed containers, suitable for transport in a charged condition.

Sealing Box, Sealing End, or Sealing Chamber. A box into which cables are brought to make connections to terminals or to other cables or conductors, filled up with compound to seal the ends of the cables.

Sealing In. The making of an airtight joint between the leading in wires of an incandescent lamp, vacuum tube, etc., and the glass, by employing a metal for that portion of the wires of the same coefficient of expansion as glass or otherwise.

Sealing In Joint. The fused glass joint between an incandescent lamp bulb and the tube into which are sealed the leading-in wires.

Sealing Off. (1) The final closing of an incandescent lamp bulb by fusing the tube by which it is connected to the pumps. (2) The covering over of the end of a cable where it has been cut, to prevent deterioration of the insulation by ingress of moisture.

Seam Welding. A resistance method of welding sheets, etc., by passing current through the two surfaces from electrodes which hold them tightly in contact while the sheets are drawn together slowly through the rollers forming the electrodes, so that a continuous seam joint is made. Cf. BUTT WELDING and SPOT WELDING.

Search Coil. A coil connected to a ballistic galvanometer or similar instrument to determine the amount of a change of flux occurring suddenly in a magnetic field; either forming a permanent part of magnetic testing apparatus or to be moved about as an *Exploring Coil*.

Searchlight. A powerful *Projector* for throwing a concentrated beam of light for distinguishing distant objects at night, e.g. for rendering visible hostile ships or aircraft. Usually consisting of a barrel with a parabolic mirror at one end and containing an arc lamp of special construction; pivoted so as to be capable of horizontal and vertical angular movement and controlled by hand, or by mechanical or electrical means from a distance. Smaller units are provided with metal filament lamps.

Secohm. A contraction of "second-ohm," formerly used as a name for the practical unit of *Inductance*; now usually called the *Henry*, or sometimes the *Quadrant*.

Secohmmeter. An obsolete instrument consisting of revolving contact makers, which enabled an ordinary Wheatstone's Bridge to be used for measurements of inductance by converting current impulses into steady deflections.

Second Class Conductor. A substance which conducts only by *Electrolytic Conduction*.

Secondary. Abbreviation for *Secondary Winding* in a transformer.

Secondary Cell. A cell consisting of electrodes in an electrolyte which can absorb energy by undergoing chemical changes when a current is passed through it, and can give the greater part of this energy out again as an electric current during reversion to its original chemical state. See ACCUMULATOR.

Secondary Circuit. The circuit containing the *Secondary Winding* of a transformer.

Secondary Clocks. The clock dials throughout an electrical time service system which are actuated or synchronised by periodical current impulses controlled by the *Primary* or *Master Clock*.

Secondary Coil. The whole or part of the *Secondary Winding* of a *Transformer*.

Secondary Contact. See AUXILIARY CONTACT.

Secondary Current. The current in the *Secondary Winding* of a *Transformer Induction Coil*, etc.

Secondary Electrode. An intermediate

electrode in an electrolytic cell not connected to the outside circuit, the opposite sides of which behave as electrodes of opposite polarity, also called *Bipolar Electrode*.

Secondary Electron Multiplier. An electron tube in which the electron stream is focused on to a succession of targets, each of which adds its secondary electrons, thus producing a considerable amplifying effect. Applicable to the amplification of the effect of photo-electric tubes and other purposes.

Secondary Electrons. Electrons emitted by the plate, anode, or other target of an *Electron Tube* when struck by the cathode stream of electrons when they are projected with sufficient velocity.

Secondary Emission. The emission of *Secondary Electrons*.

Secondary Generator. A name formerly used for a *Transformer*.

Secondary Leakage. The passage of magnetic flux due to current in the secondary winding of a transformer or the armature of a generator, etc., through a path which does not embrace the main magnetic circuit.

Secondary Radiation. See **SECONDARY "X" RAYS**.

Secondary Standard. A copy representing as accurately as possible a *Primary Standard*, and used for comparisons in a standardising laboratory. Also called *Reference Standard*.

Secondary Voltage. The voltage at the terminals of the *Secondary Winding* of a transformer, which may be higher or lower than the *Primary Voltage*, according to whether the transformer is stepping up or down.

Secondary Winding. The winding of a transformer which is not connected to the source of supply, i.e. is connected to the output side, irrespective of whether the voltage in it is higher or lower than that of the *Primary Winding*.

Secondary "X" Rays. Rays of similar character to ordinary "X" Rays, which are given off by solid and other bodies when ordinary "X" Rays fall upon them, at a

frequency or frequencies characteristic of the substance.

Secret Switch. See **LOOKED COVER SWITCH**.

Section Box. A cable box in which different sections of a cable network, etc., are joined together by links which may be removed for isolation of a section for testing or repair. Cf. **SECTION PILLAR**.

Section Circuit-Breaker. A circuit-breaker arranged to cut one section of a tramway or other line off from the supply in case of overload or fault.

Section Fuse Board. See **DISTRIBUTION FUSE BOARD**.

Section Insulator. A fitting for mechanically connecting but electrically insulating the ends of two adjacent sections into which an overhead contact line is divided, while still affording a smooth path for the trolley wheel or other collector.

Section Multiple. A term used for the whole group of multiples in a section in automatic telephony.

Section Pillar. A section box in the form of a pillar.

Section Switch. See **SECTIONALISING SWITCH**.

Sectional Coil. A coil, such as the secondary winding of an induction coil, made up of several separately insulated sections placed side by side, in order to avoid great differences of potential between layers.

Sectionalised Bus-Bars. Bus-Bars arranged so that they can be divided up into a number of separate sections by suitable switchgear, so that faulty sections can be cut out for inspection or repair, or different portions of the generating plant can be connected to different feeders or groups of feeders.

Sectionalising Switch. A switch for dividing up a circuit or conductor into disconnected portions.

Sector Pattern Instruments. Switch-board instruments made up in sector-shaped cases instead of with round dials.

Secular Variation. The slow variations in the earth's magnetic field which take many years to perform their complete cycle. Thus the

Declination performs a complete swing in both directions and back to the same value in about 640 years. Cf. ANNUAL VARIATION and DIURNAL VARIATION.

Seebeck Effect. The fact discovered by Seebeck in 1821 that heating the point of contact of two dissimilar metals can produce an e.m.f.

Segment : Commutator, Contact, and Dead. See COMMUTATOR SEGMENT, CONTACT SEGMENT, etc.

Segmental Conductor. A conductor in a cable made up of strands of segmental section fitting together to form a ring-shaped section.

Segmental Core Discs. Core discs for large armatures, etc., each made up of several segment-shaped pieces assembled to break joint with each of the adjacent discs.

Seismophone. A special form of microphone for placing in contact with the ground to detect sounds coming through the earth; e.g. for locating enemy tunnelling operations in war.

Selectance. The property of wireless receiving systems whereby they can be tuned to discriminate between simultaneous signals of not greatly differing wave lengths.

Selecting Switch (in Electric Lift Control). That part of the control gear in an automatic lift which determines at which floor the car stops.

Selective Collective Automatic Lift Control. A system in which calls are answered in a predetermined order. See also DIRECTIONAL COLLECTIVE AUTOMATIC LIFT CONTROL.

Selective Commutation. The unequal division of current between the brush arms that is liable to occur in Wave-Wound machines with as many brush arms as there are poles.

Selective Fading. See DIFFERENTIAL FADING.

Selective Radiation. Radiation by a hot body or by luminescent gases, etc., of rays of a limited range of frequencies only, i.e. giving a discontinuous spectrum.

Selective Receiver. A wireless telegraph, etc., receiver which responds only to a particular wave length.

Selective Reflection. Reflection of rays of a certain group of frequencies only, or to a markedly greater extent than all other rays.

Selective Resonance. Resonance to one frequency only.

Selective Ringing. *Party Line Ringing* in which the bells are arranged so that only that of the called subscriber rings; either by employing bells connected in the different sides of the line and some biased so as to ring only with pulsating and not with alternating current, or by the method known as *Harmonic Ringing*.

Selectivity. The degree to which the response of a wireless receiving apparatus is limited to one wavelength, otherwise called *Sharpness of Tuning*.

Selector. In general: An apparatus for responding to a prearranged series of current impulses or wave trains only, or an automatic or other apparatus for making connection to any one of a number of circuits at will. In automatic telephony: An automatically actuated multiple contact switch, group of switches, or other device which makes contact with any desired circuit, either controlled by a step by step method depending on a varying number of current impulses, or arranged to select a disengaged line by "hunting" over a number of contacts and stopping at one when conditions are realised which bring a relay into action.

Selector : Code, Digit, Discriminating, Final, First, Group, Hundreds, Junction, Line, Numerical, Pre-, Private Branch Exchange Final, Repeating, Tandem, and Thousands. See CODE SELECTOR, DIGIT SELECTOR, etc.

Selector Repeater (in Automatic Telephony). A *Selector* which, after acting as a *Group Selector*, repeats all further impulses.

Selector Repeater, Discriminating. See DISCRIMINATING SELECTOR REPEATER.

Selector Switch. An automatic or other switch for connecting a machine or apparatus to any one

of a number of circuits. See also **LINE SELECTOR**.

Selenium Amplifier. See **SELENIUM MAGNIFIER**.

Selenium Bridge. See **SELENIUM CELL**.

Selenium Cell. A small block or "cell" containing, between suitable electrodes, a small quantity of selenium, a substance the resistance of which becomes less when light falls upon it. Used, on account of this property, for various purposes, but superseded to a considerable extent by other forms of *Light Sensitive Cell*. Cf. **THALOFIDE CELL** and **PHOTO-ELECTRIC CELL**.

Selenium Density Meter. An apparatus for measuring the light absorption of opalescent materials by comparison with that of a standard optical wedge, using a *Selenium Cell* upon which the light of a lamp falls alternately through the two, adjustment being made until no current variation is produced.

Selenium Magnifier (or "Amplifier"). An apparatus for increasing the strength of signals received over submarine cables in which a beam of light is deflected by a mirror on the moving coil, causing variation of relative resistances of two selenium cells in opposite arms of a Wheatstone's Bridge, upon which it normally falls equally.

Selenium Relay. (1) A *Relay* in which the weak actuating current controls the illuminations of a *Selenium Cell* causing variation of current therein of much greater intensity. (See **SELENIUM MAGNIFIER** and **ALLSTROM RELAY**.) (2) An apparatus in which light variations are converted by a *Selenium Cell* into current variations.

Selenophone. An early sound film system.

Self-Baking Electrode. A form of *Continuous Electrode* for arc furnaces in which a soft mixture is fed into a tube. The lower end of the column thus formed is the actual electrode and is baked hard by the heat of the arc.

Self-Balancing Protective System. A protective system for generators, etc., in which the connections from

both ends of each phase winding pass through a current transformer, balancing each other when the currents in them are equal, so that a current is only produced in the secondary when, owing to a fault, the currents in and out of the individual phase windings are unequal. The secondaries are connected to relays which trip the main circuit-breaker when this lack of balance occurs. The system does not, however, guard against faults between turns.

Self-Capacitance. The capacitance incidentally present in a piece of apparatus, such as that between turns of an inductance coil in wireless receiving apparatus.

Self-Cleaning Contacts. Rubbing contacts which clean themselves as the switch, etc., is opened or closed.

Self-De magnetising Force. The de-magnetising effect of the lines of force from pole to pole of a permanent magnet in the medium surrounding it, producing as they do a field in the opposite direction to the magnetisation of the bar, etc., itself; greatest with a short bar magnet, and non-existent with a closed magnetic circuit where all the lines of force are within the iron. See also **KEEPER**.

Self-Excitation. The supply of current to the field circuit of a dynamo from its own armature, as in shunt, series and compound wound machines. Cf. **SEPARATE EXCITATION**.

Self-Excited Generator. See **SELF-EXCITATION** and **SELF-EXCITING ALTERNATOR**.

Self-Exciting Alternator. An alternator in which the excitation is derived from the alternating current given by the machine itself by some kind of rectifier or commutator. See **HEYLAND ALTERNATOR** and **PANCHRONOUS ALTERNATOR**.

Self-Heterodyne. See **ENDODYNE**.

Self-Inductance. The property of a circuit by which self induction occurs, measured by the rate of change of flux linkage caused by unit rate of change of current in the circuit itself. Symbol: *L*. Cf. **MUTUAL INDUCTANCE**, and see also **INDUCTANCE**.

Self-Induction. The production of an e.m.f. in a circuit due to a change in the flux linking that circuit caused by a change of current in the circuit itself.

Self-Induction, Coefficient of. See COEFFICIENT OF SELF-INDUCTION.

Self-Oscillation. Oscillation produced in a valve circuit of a wireless receiver, either caused accidentally by excessive reaction, or purposely for *Endodyne Reception*, etc.

Self-Oscillator Transmitter. A *Thermionic Valve* transmitter in which the oscillations are produced by the effect of *Retraction* between the anode and gr.d. circuits (except in the case of magnetron and electron oscillatives).

Self-Registering or Self-Recording Instruments. See RECORDING INSTRUMENTS.

Self-Regulating. Machinery or apparatus which itself automatically regulates current, voltage, speed, or other function without the necessity of hand or automatic operation of a separate regulating apparatus.

Self-Restoring Coherer. A *Coherer* which reverts to its initial condition of high resistance as soon as the oscillations which have stimulated it cease, without necessity for mechanical disturbance.

Self-Restoring Indicator. An *Indicator* for bell circuits, etc., which reverts automatically to its original condition after the signal has been given and does not require to be replaced by hand. Cf. HAND RESTORING INDICATOR.

Self-Starter. A small motor supplied with current from an accumulator battery, used to start the petrol engines of automobiles. Usually arranged to shift a pinion into gear with tooth on the engine fly-wheel by the starting of the motor, which drops out of gear automatically when the engine starts.

Self-Starting Rotary Converter. A rotary converter arranged for starting up from the alternating current side as an *Inverted induction motor*, or otherwise, without the necessity of a separate starting motor.

Self-Synchronising. A synchronous

machine is said to be "self-synchronising" when it does not require the exact moment when it is in correct frequency, phase, etc., to be waited for before it can be switched on to the main circuit, e.g. a *Self-Starting Rotary Converter* or a *Synchronised Induction Motor*. Cf. AUTOMATIC SYNCHRONISER.

Self-Ventilated Motor, etc. A class of motor, etc., not requiring independent blowers, etc., for their ventilation, e.g. a *Fan-cooled Motor*.

Self-Winding Clock. An electric clock in which the spring, etc., which drives it in the ordinary way is re-wound by an electrically driven mechanism automatically by the closing of a contact when run down, so that if once connected to a source of supply it will work indefinitely without attention.

Selsyn System. A system of remote instrument indication employing self synchronising transmitters.

Semiabsolute Volt. The potential difference at the terminals of one *International Ohm* when one absolute or true ampere is passing. Used sometimes in stating the e.m.f. of standard cells, that of the Weston Cell at 20° C. being 1.08121 semiabsolute volts.

Semi-Arc Lamp. See SEMI-INCANDESCENT LAMP.

Semi-Automatic Lift Control. Electric lift control in which push buttons are employed for "up," "down," and "stop" only. Cf. AUTOMATIC LIFT CONTROL.

Semi-Automatic Substation. A substation, in which the switchgear is automatic as regards the sequence of the starting operations, etc., but is only put in action by remote control from a central point or a neighbouring substation. This arrangement is known as *Supervisory Control*.

Semi-Automatic Telephone System. A telephone system in which personal operators are employed who ascertain the calls verbally but actuate automatic apparatus to obtain the required connections. (Also called *Automanual System*.) See TRAFFIC DISTRIBUTOR.

Semi-Circular Deviation or Error. The

effect on a ship's magnetic compass of permanent magnetism in the iron or steel in the ship's hull, etc., which becomes a maximum twice when the ship is "swung" or rotated through 360°. Corrected by placing two horizontal sets of permanent correcting magnets below the compass, athwartships and fore and aft respectively. Cf. QUADRANTAL DEVIATION.

Semi-Closed Slots. See HALF-CLOSED SLOTS.

Semi-Distributed Winding. An armature or other winding which does not occupy the whole surface of the core, but is evenly distributed in slots or otherwise over the portions that it does occupy, being intermediate in its arrangement between a *Distributed Winding* and a *Concentrated Winding*. Used in rotors of turbo-generators without salient poles, or in the armatures of some designs of single-phase alternators.

Semi-Enclosed Cut-Out or Fuse. A *Cut-Out* with the *Fuse-Link* partly covered in.

Semi-Enclosed Motor. A motor with end shields protecting the windings with apertures large enough to afford free ventilation, sometimes covered with expanded or perforated metal screens. See FULLY-ENCLOSED, ENCLOSED VENTILATED and PROTECTED MOTORS.

Semi-Enclosed Switchgear. See ENCLOSED VENTILATED SWITCHGEAR.

Semi-Flush Switch. See SEMI-RECESSED SWITCH.

Semi-Immersed, Liquid Quenched Cut-Out or Fuse. A *Liquid Quenched Cut-Out* in which the *Fuse-Link* is only drawn under the surface of the quenching liquid at the moment of breaking. Cf. IMMERSED LIQUID QUENCHED CUT-OUT.

Semi-Incandescent Lamp. A name given to an early form of electric lamp in which the loose contact between a thin carbon pencil and a larger carbon electrode was heated by the current and caused incandescence of the tip of the pencil. (Also sometimes called *Semi-Arc Lamp*.)

Semi-Indirect Fittings. Fittings pro-

vided with alabaster or other opalescent reflectors for *Semi-Indirect Lighting*.

Semi-Indirect Illumination or Lighting. Lighting in which the lamps are placed in opalescent bowls, etc., which, although transmitting and diffusing a portion of the light, reflect the remainder and direct it to the ceiling and upper part of the walls, whence it reaches the areas to be illuminated by diffused reflection. Cf. DIRECT LIGHTING and INDIRECT LIGHTING.

Semi-Recessed Switch. A *Branch Switch* partly recessed into the wall so that the cover only projects slightly.

Semi-Rigid Suspension. Catenary or other suspension of an overhead contact line in which the line wire is anchored at intervals as regards vertical and lateral movement by rigid rods, instead of being constrained only by flexible hangers.

Semi-Sunk Switch. See SEMI-RECESSED SWITCH.

Sender. A piece of apparatus in the *Panel Automatic Telephone System* which receives the calling impulses and translates them into suitable form for operating the various selectors.

Sensibility (of a Galvanometer, etc.). The relation between the change in deflection produced by a small change of current and any part of the scale and the change of current producing it. Cf. SENSITIVITY.

Sensitiveness. See SENSITIVITY.

Sensitivity (1) of a GALVANOMETER.

The relation between the deflection and the current producing it. Usually expressed as the deflection or throw in millimetres on a scale one metre distant, produced by one micro-ampere, microvolt, or micro-coulomb, as the case may be. (2) *Of a Cathode Ray Tube.* The displacement in mm. of the luminous spot on the screen per volt applied to the deflecting plates (electric and sensitivity) or per ampere applied to the deflecting coil (magnetic sensitivity).

Sentinel Gas. See GAS DETECTOR.

Separate Excitation. The supply of exciting current to the field circuit

of a generator from an independent source or of a motor from a source different from that from which the armature is supplied.

Separate Exciter. An auxiliary generator used for the excitation of one generator only and usually driven by the same shaft.

Separate Heterodyne. Heterodyne reception in which an independent oscillation is used to produce the auxiliary oscillations.

Separated Phase Switchgear. See ISOLATED PHASE SWITCHGEAR.

Separately Air-Cooled Motor. A *Totally Enclosed Motor* cooled by an air stream from a separately driven fan.

Separately Excited Generator, Motor, etc. See SEPARATE EXCITATION.

Separately Lead-Covered (S.L.) Cable. A multicore high tension cable with each core separately lead-covered to control the distribution of potential in the dielectric as well as for protection.

Separator. In an accumulator cell: A non-conducting structure placed between the plates to prevent the possibility of accidental contact; of glass, obonite, etc., rods or tubes, or thin sheets of specially prepared wood, colluloid, etc.

Separator: Dielectric, Electrostatic, Ore, and Magnetic. See DIELECTRIC SEPARATOR, ELECTROSTATIC SEPARATOR, etc.

Separator Buffer. A valve circuit interposed between a master oscillator in an independent drive system, and the modulated valves to minimise influence of the modulations on the steadiness of the frequency of the carrier waves.

Sequence Switch. A switch closing a number of circuits in a predetermined order.

Series: Contact, Electrochemical, and Thermoelectric. See CONTACT SERIES, ELECTROCHEMICAL SERIES, etc.

Series Arc Furnace. An *Arc Furnace* in which two arcs are formed between the charge and the two electrodes respectively.

Series Arc-Lamp. (1) An arc-lamp with controlling solenoids or magnet windings in series with the main current only. Cf. SHUNT ARC-

LAMP. (2) An arc-lamp constructed for running in series with others.

Series Arc-Lighting. Street lighting, etc., by arc-lamps of which a considerable number are connected in series on one circuit and a comparatively high voltage is used.

Series Capacitor. A bank of oil-immersed condensers in series with the line for power factor improvement, usually with an automatic by-pass device for short-circuit conditions.

Series Characteristic (of a Generator). A curve showing the relation of voltage to current, such as is shown in the case of a series wound dynamo; rising sharply at first and bending over and becoming flatter as the current increases.

Cf. SHUNT CHARACTERISTIC.

Series Characteristic Motor. A motor with a characteristic similar to that of a *Series Motor*.

Series Circuit (in Meters). See CURRENT CIRCUIT.

Series Coil. The winding (or a part thereof) forming a separate coil which carries the main current in a compound or differentially wound machine or apparatus. Cf. SHUNT COIL.

Series Compensated Motor. See COMPENSATED SERIES MOTOR.

Series Condenser. A condenser used in series with an electrostatic voltmeter to increase its range.

Series Conduction Motor. A commutator motor with the field winding in series with the armature.

Series Connection. Lamps, coils, or other apparatus, or parts of circuits of any kind, are said to be connected "in series" when connected together to form a single circuit, so that the whole of the current passes through them all without dividing, and the e.m.f.'s all act in the same direction. Cf. PARALLEL, MULTIPLE SERIES, and SERIES MULTIPLE CONNECTIONS.

Series Cut-Out. A device for cutting a series arc-lamp or other apparatus out of circuit and diverting the main current by short-circuiting the terminals or connecting across them a *Substitutional Resistance*.

Series Distribution. A system of distribution of electrical energy

for power, lighting, etc., in which all the apparatus, motors, lamps, etc., are connected in *Series* on a single circuit; usually with constant current regulation. See **THURY SYSTEM**.

Series Diverter. A variable low resistance connected in parallel with a series field or other coil to regulate the current therein by diverting a fraction thereof.

Series Dynamo. See **SERIES-WOUND DYNAMO**.

Series Excitation. Excitation of a motor or generator by passing the main armature current through the field winding.

Series Field. That part of the total flux in the magnetic circuit of a machine due to the series winding.

Series Generator. See **SERIES-WOUND GENERATOR**.

Series Incandescent Lighting. Lighting by incandescent lamps connected in series.

Series Induction-Conduction Motor. A type of single-phase commutator motor equivalent to a plain series motor in characteristic, in which the armature circuit is connected by a transformer to the main circuit. Cf. **SERIES-CONDUCTION MOTOR**.

Series Lamp. A lamp for running in series with others of the same design, all accurately adjusted to work with exactly the same current. See also **SERIES ARC-LAMP**.

Series Modulation. A system of modulation employed in large wireless transmitters in which the main modulating valve and the modulated amplifier valve and the high-tension supply are all in series. The variations in impedance of the modulator anode circuit caused by the modulations of the grid voltage directly affect the voltage applied to the amplifier valve.

Series Motor. A motor of the commutator type in which the field and armature windings are connected in series; used for direct current and with slight modifications, including lamination of the field as well as the armature, also for alternating current. In view of the fact that the strength

of the field varies with the armature current, such motors can produce a high torque at starting, and run at a speed depending upon the load, running slowly when heavily loaded and faster as the load is decreased. They are thus particularly suitable for traction and crane work, etc., but cannot be employed where there are times when the load is practically entirely removed, as the speed may then increase to a dangerous extent. Cf. **SHUNT MOTOR**.

Series Motor, Compensated and Neutralised. See **COMPENSATED SERIES MOTOR** and **NEUTRALISED SERIES MOTOR**.

Series Notches. The positions of a *Series-Parallel Controller* in which the motors are in series, with or without resistance in circuit. Cf. **FULL SERIES, PARALLEL, FULL PARALLEL, RUNNING, and RESISTANCE NOTCHES**.

Series Positions. See **SERIES NOTCHES**.

Series Relays. A pair of relays used in some protective systems in series, one with high sensitivity but some time lag for dealing with small continuing fault currents, and the other instantaneous in action but less sensitive for dealing with heavy currents from the rest of the system.

Series Transformer. See **CURRENT TRANSFORMER**.

Series Transformer System. An arrangement of transformers to minimise light load losses by employing a small auxiliary transformer, with both its primary and secondary windings in series with those of the main transformer, to take the load when it is low, and an automatic switch to short-circuit the windings of the auxiliary transformer when the load exceeds a certain value. Often known as the **BERRY TRANSFORMER SYSTEM**.

Series - Multiple Connection. An arrangement of connections in which a number of groups of several cells, lamps, etc., in *Parallel*, are connected in *Series*. Cf. **MULTIPLE SERIES**.

Series-Parallel Battery Control. A method of control of motors on

battery-driven vehicles by connecting portions of the battery alternatively in series and parallel.

Series-Parallel Connection. (1) See **SERIES-MULTIPLE CONNECTION**. (2) Alternative connection in series or in parallel, as in **SERIES-PARALLEL CONTROL**.

Series-Parallel Control. The control of two or more motors by connecting them sometimes in series and sometimes in parallel. Extensively used for traction motors which are connected in series at starting and for low speeds, and in parallel for higher speeds, with or without resistances in series. A similar system is employed with single motors with two commutators, and can be applied to the solution of a number of other special problems, including the grouping of incandescent lamps normally in parallel, in series when only a dim light is required.

Series-Parallel Controller. A *Controller* for two or more motors which, by the movement of one handle, connects them in series of parallel or connects groups of them in series or parallel, and is usually provided with positions where a greater or less amount of resistance can be included in series with their armatures, and sometimes with additional positions where a higher speed is obtained by weakening the fields by shunting them with a resistance, and for re-arranging the connections for electric braking. See **CONTROLLER NOTCHES** or **POSITIONS**. Such a controller may be of the drum or other pattern containing contacts where the connections are made in the apparatus itself, or may be a *Master Controller* actuating a number of *Contactors*. The connections are generally so arranged that the change from series to parallel and vice versa can be made without breaking the main circuit. See **BRIDGE TRANSITION**.

Series-Parallel Field Control. Speed control of traction motors in which portions of the field windings are connected alternatively in series and in parallel.

Series-Parallel Switching Starter. A motor starter which connects motors, commutators, or parts of motor windings temporarily in series for starting conditions only, but is not designed to effect speed control generally.

Series-Parallel Switch. A switch for changing the connection of lamps or other apparatus from series to parallel, and vice versa.

Series-Parallel Winding. Another name for *Multiplex Wave Winding*.

Series-Wound Arc Lamp. See **SERIES ARC LAMP**.

Series-Wound Dynamo or Generator. A direct current generator in which the field winding is in series with the armature winding. Giving a voltage varying according to the load. See **SERIES CHARACTERISTIC**. Rarely used except for *Constant Current Systems*. See **THURX SYSTEM**.

Series-Wound Motor. See **SERIES MOTOR**.

Served Lead-Covered Cable. Lead-covered cable having a protective serving of jute or other material over the lead sheathing.

Service. See **SERVICE LINE**.

Service Line. The cable which forms the connection between the distributing mains and the consumer's installation in a house or other building.

Serving. Jute, tape, or other material wound onto a cable to give a soft protective layer, sometimes permeated with waterproof compound.

Servo-Motor. A motor employed, especially in control apparatus, steering gear, etc., to act as a mechanical relay, i.e. to convert a small movement into one of greater amplitude or with greater force available to effect it. See **PILOT MOTOR**.

"S.E.S." Lamp Cap. See **SMALL EDISON SCREW CAP**.

Set-Up Scale. The scale of a suppressed zero instrument.

Shackle Insulator. An insulator formed by a reel of porcelain, etc., mounted on a spindle held at both ends by a metal shackle.

Shade. A translucent or opaque covering placed over or round a

lamp to diffuse the light or to cut it off entirely in directions where not required, of glass, paper, card, metal, or silk stretched on a wire frame, etc. Cf. REFLECTOR.

Shade, Opal. See OPAL SHADE.

Shade Carrier Ring. A ring screwed on to the outside of the barrel of the ordinary bayonet lamp holder for the support of a shade. Cf. GALLERY.

Shaded Pole. See SHIELDED POLE.

Shadow Photometer. A form of photometer in which the shadows cast by the light source to be tested and the standard are compared and brought to equality by varying the relative distances of the sources from the screen. Also called *Rumford Photometer*.

Shaft, Armature and Jack. See ARMATURE SHAFT and JACK SHAFT.

Shaft Cable. A specially protected cable of considerable tensile strength for attaching to the sides of a vertical mine shaft.

Shaft Currents. Stray currents flowing through the shaft and bearings of generators, etc., liable to cause corrosion of the bearings and journals as well as energy loss.

Shaped Conductor. A conductor of other than circular section.

Sharp Bend. See ELBOW.

Sharp Tuning. The necessity for very fine adjustment of the tuning apparatus of a wireless receiver to obtain response to a particular wave-length.

Sharp and Millar Photometer. A portable form of illumination photometer on the *Lummer-Brodhun* principle.

Sharpness of Directivity (of a Directional Aerial). The degree of directional property as measured by the change of signal strength corresponding to a small angular displacement.

Shearer Tube. An "X" ray tube with an envelope of metal with porcelain insulation instead of glass.

Sheath. (1) See CABLE SHEATHING. (2) Term sometimes used for the *Anode* (plate) of a thermionic valve when it surrounds the *Cathode*. (3) In a discharge tube. The regions near the electrodes or near the wall of the tube where the presence of

space charges causes unequal positive and negative electron concentration. Cf. PLASMA.

Sheath Fish (Electric). See a fish with similar electrical properties to those of the *Ray* or *Catfish*.

Sheath Losses. Energy losses in cables due to circulating currents in the sheath.

Sheathed Electrode (in Arc Welding). A metal electrode with a covering of flux material and an outer metal sheath.

Sheathing: Cable, Cab-Tyre, Lead, and Tough Rubber. See CABLE SHEATHING, CAB-TYRE SHEATHING, etc.

Sheet Lightning. The sudden illumination of a part of the night sky by a flash of lightning not directly visible to the eye. Cf. FORKED LIGHTNING.

Shell, Magnetic. See MAGNETIC SHELL.

Shell Type Transformer. A transformer in which the primary and secondary coils are first made up and placed together, and the iron core is built through and round them with magnetic return paths outside and protecting the coils, except at the ends. Cf. CORE TYPE TRANSFORMER.

Sheringham Daylight Lamp. A form of *Daylight Lamp* in which the selection of the rays to be utilised is made by coloured reflectors instead of transparent screens.

Shield: Arc, Earth, Electrostatic, End, Magnetic, and Test. See ARC SHIELD, EARTH SHIELD, etc.

Shielded Arc Welding. A method of arc welding in which the arc and molten metal are shielded by a protective gas.

Shielded Grid Valve. See SCREENED VALVE.

Shielded Pole. A magnet pole in an alternating current instrument of the *Induction Type*, provided with a conducting ring, etc., round it, forming a closed secondary winding and altering the phase angle of the flux therein relatively to other poles without such rings, to obtain a rotary field. Also called *Shaded Pole*.

Shielded "X" Ray Tube. An "X" Ray Tube enclosed, except for a

small window, by an earthed metallic container. Cf. RAY PROTECTED "X" RAY TUBE.

Shifting of Brushes. Alteration of the angular position of the brushes on a *Commutator*, i.e. giving a greater or less amount of *Forward* or *Backward Lead* to give the most advantageous conditions for sparkless commutation.

Shim. A packing plate, e.g. one of magnetic material placed between a pole piece and the yoke to adjust the air gap.

Ship, Cable. See CABLE-SHIP.

Ship Error (in Wireless Direction Finders). An error due to re-radiation of a vertical wave by the metal work of the ship.

Shock (Electric). The sudden pain, convulsion, or unconsciousness, sometimes with fatal result, produced by the passage of a current through the body. The voltage which can produce such an effect varies very greatly with conditions and with different subjects, according to the resistance of contact with the skin, whether dry or damp, and the internal resistance of the part of the body in question, as well as the sensibility of the nervous system. Alternating currents at industrial frequencies of supply have more effect than direct currents at the same voltage, but at very high frequencies much greater currents can be passed through the body without inconvenience or danger.

Shock, Return. See RETURN SHOCK.

Shock Excitation. The starting of damped oscillations in a wireless transmitting circuit by a spark discharge or other sudden surge. See SPARK SYSTEM.

Shock-Proof Switch. A switch with all accessible parts covered with insulating material.

Shock Reception. Wireless reception of signals from a powerful station at close range, independently of exact tuning of the receiving circuit to resonance, i.e. by forced oscillations.

Shocking Coil. Popular name for an induction coil for producing a high intermittent voltage such as can produce a moderate electric shock.

Shoe : Collecting, Contact, Pole, and Trolley. See COLLECTING SHOE, CONTACT SHOE, etc.

Shore-End Cable. The heaviest type of submarine cable, for use where it emerges for connection to the shore circuits. Cf. DEEP SEA and INTERMEDIATE CABLE.

Short. Colloquial abbreviation for *Short-Circuit*.

Short, Dead. See DEAD SHORT.

Short-Break Switch. A low voltage a.c. switch with a contact separation of about 0.01 in., in which the small arc formed is extinguished by the cooling effect of the contacts.

Short Chord Winding. See FRACTIONAL PITOH WINDING.

Short Circuit. A connection, accidental or otherwise, between two points having a difference of potential between them, of sufficiently low resistance to allow a very much larger current to flow than is normally the case; so large, sometimes, as to produce considerable damage.

Short-Circuit Characteristic. A curve showing the relation between current produced when the armature is short-circuited and the excitation.

Short-Circuit Current. The current which will be produced by an alternator, etc., when short-circuited under normal conditions of speed and excitation.

Short-Circuit Generator. A special alternator for testing circuit-breakers, etc., capable of giving a very heavy current for a very short time usually partly by the aid of a heavy flywheel. The maximum momentary output may be equal to more than 20 times the continuous rating of an ordinary machine of the same size.

Short-Circuit Key. A key connected to the terminals of a galvanometer or other apparatus to short-circuit it when required. This is done in the case of a *Ballistic Galvanometer* to bring it to rest quickly by means of the damping effect of the currents induced in the moving coil.

Short-Circuit Test. A determination of a *Short-Circuit Characteristic*.

Short-Circuit Transition. A method of changing from series to parallel in traction controllers, without breaking the circuit, involving short-circuiting one motor. Cf. **BRIDGE TRANSITION.**

Short-Circuited Rotor. A rotor of an *Induction Motor* in which the conductors form a number of paths of low resistance entirely within the rotor and thus without *Skip-Rings*. See **SQUIBBEL-CAGE ROTOR.**

Short-Circuiting Device. An arrangement within the rotor of a slip-ring type *Induction Motor* whereby the slip-rings can be short-circuited after the starting resistance has been cut out in order that the brushes may be lifted off the slip-rings; actuated by hand by means of a spindle projecting from the end of the shaft, by a fork shifting a floating collar on the shaft, etc., or automatically by a centrifugal device within the rotor.

Short Shunt Compound Winding. A compound field winding in a dynamo where the *Shunt Winding* is connected direct to the brushes, i.e. on the machine side of the *Series Winding*. Cf. **LONG SHUNT.**

Short Throw Coil. An *Armature Coil* of which the angle embraced between the two sides is less than the pitch.

Short Type Coil. An *Armature Coil*, for windings where axial space is limited, with the end connections bent round to lie against the end of the core instead of lying flat on a cylindrical surface as in a *Barrel Winding*.

Short Wave Adaptor. An apparatus which can be connected to a medium wave wireless receiver to enable it to receive short wave signals.

Short Wave Therapy. Curative applications of an electric field with a frequency of oscillation corresponding to a wavelength of 3 to 50 metres.

Short Waves. An expression often used for waves below 100 metres but limited by the definition of the International Radio-technical Committee to waves between 10 and 50 metres (30,000 to 6,000 kc.). Cf.

LONG, MEDIUM, INTERMEDIATE, and VERY SHORT WAVES.

Shortener, Cord. See **CORD SHORTENER.**

Shortening Condenser. A condenser placed in series with an aerial or other wireless telegraph circuit to shorten the wave length at which it radiates or to which it responds. Cf. **LENGTHENING INDUCTANCE.**

Shot Effect (in Thermionic Valves). A slight fluctuation in the anode current, due to the fact that the emission within the tube is not really continuous but is a slightly irregular bombardment due to the finite charge carried by each electron. Also called *Schrotrky Auto-electronic effect*. Cf. **JOHNSTONE NOISE.**

Shot Firing (Electric). See **BLASTING.**

Shot Firing Cable. A special type of cable for use in mines, etc., for *Shot Firing* purposes.

Shot Firing Generator. See **MINE EXPLODER.**

Shrink-Ring Commutator. A type of commutator used in very high speed generators, motors, etc., in which the segments are held in place against centrifugal force by steel rings shrunk on over a layer of mica.

Shrouded Magnet. A name occasionally used for an *Ironclad Electromagnet*.

Shunt. A path for a current in parallel with an apparatus or part of a circuit; usually of widely differing resistance, lower in the case of a galvanometer or other instrument to which a shunt is applied to increase its range, and higher in the case of the shunt winding of a motor, arc-lamp, meter, etc. A shunt is sometimes described as a *By-pass*.

Shunt: Galvanometer, Long, Magnetic, Multiplying Power of, Resonant, Short, and Universal. See **GALVANOMETER SHUNT, LONG SHUNT, etc.**

Shunt Arc-Lamp. An arc-lamp the regulating mechanism of which is provided only with solenoids or magnets connected across the voltage of the circuit. Cf. **SERIES ARC-LAMP.**

Shunt Box. A box containing a

number of resistances arranged with plugs, etc., for use as a galvanometer shunt giving a number of degrees of sensitiveness.

Shunt Box: Compensated and Universal. See COMPENSATED SHUNT BOX and UNIVERSAL SHUNT BOX.

Shunt Characteristic. A curve showing the relation of voltage to current, such as is shown in the case of a shunt wound dynamo, where the voltage falls off more and more rapidly as the current increases up to the maximum current that the machine can give, and continues to fall off with decreasing current if the resistance of the outside circuit be further lowered. See CRITICAL RESISTANCE, and cf. SERIES CHARACTERISTIC.

Shunt Circuit. Any part of a circuit in parallel with any other; more particularly a circuit connected across the main voltage in apparatus which also contains coils, etc., in series with the main current.

Shunt Coil. The field winding, or that part forming a separate coil, which is connected to the brushes or main terminals in a shunt compound or differentially wound machine or apparatus. Cf. SERIES COIL.

Shunt Dynamo. See SHUNT WOUND DYNAMO.

Shunt Excitation. (1) Excitation of a motor or generator by connecting the field winding to the brushes or the main terminals. (2) That part of the excitation of a compound or differentially wound machine due to the shunt winding. Cf. SERIES EXCITATION.

Shunt Field. That part of the flux in the magnetic circuit of a machine due to the ampere turns provided in the shunt winding.

Shunt Field Relay. A relay with two windings in parallel arranged so that when the current in one is reversed the flux is caused to traverse a shunt magnetic circuit.

Shunt Field Rheostat. See SHUNT REGULATOR.

Shunt Motor. A motor of the commutator type in which the field winding is connected in parallel with the armature. Used for direct current only and suitable for

driving machinery, etc., where a practically constant speed is required at all loads and the supply voltage is practically constant. See SERIES MOTOR, DIFFERENTIALLY WOUND MOTOR, and COMPOUND WOUND MOTOR.

Shunt Ratio. See MULTIPLYING POWER (of a Galvanometer Shunt).

Shunt Regulator, Regulating Resistance, or Rheostat. A variable resistance in the shunt field circuit of a shunt or compound wound machine for controlling its voltage if a generator, or its speed if a motor.

Shunt Running. The tendency in meters in which a slight additional constant torque is provided by an auxiliary shunt coil helping the series winding, for the compensation of friction, to continue running at a low speed even when the load is entirely removed. Also called *Creeping*.

Shunt Transition. See SHORT-CIRCUIT TRANSITION.

Shunt Winding. A winding in a machine, instrument, etc., which is connected directly across the voltage of the circuit, as distinguished from a winding in series with the main current, e.g. the field winding of a shunt wound generator, etc. Cf. SERIES WINDING.

Shunt Wound Dynamo or Generator. A direct current generator in which the field winding is in parallel with the armature winding; giving a voltage only falling off slightly as the load increases, under conditions of constant speed and excitation; suitable for use in conjunction with a shunt rheostat for constant voltage systems, for accumulator charging, etc. Cf. SERIES WOUND and COMPOUND WOUND GENERATORS.

Shunt Wound Motor. See SHUNT MOTOR.

Shunt-Breaking Resistance. See FIELD-BREAKING RESISTANCE.

Shunt-Conduction Motor. A class of alternating current commutator motor, similar to a *Shunt-Induction Motor*, except that the connection between the armature and the main circuit is conductive.

Shunted Ammeter, Meter, etc. An ammeter or other instrument in which the range of current with which it will work is increased by the use of a shunt or low resistance placed in parallel with its current coil so that only a known fraction of the total current to be measured passes through the instrument itself. See SHUNT.

Shunted Condenser. A condenser in parallel with a high resistance used in telegraph circuits etc., to compensate for the retarding effect of inductance and to improve the speed of working.

Shunted Field Control. Traction motor control in which, in the higher speeds, the fields are weakened by shunting with resistances. Cf. TAP FIELD CONTROL.

Shunt-Induction Motor. A class of alternating current commutator motor with inductive connection to the armature circuit; running at approximately constant speed at all loads. Cf. SHUNT-CONDUCTION MOTOR.

Shuttle Armature. A simple form of armature now rarely used, except in very small machines, with a single coil connected to a two-part commutator and lying in the two broad slots in an elongated core built up of stampings in the shape of an H with rounded sides. Also called *Siemens "H" Armature*.

Side: "A" and "B." See "A" SIDE and "B" SIDE.

Side Band. A term used in *Wireless and Carrier Wave Telephony*, etc., for a group or *Band of Waves* of frequencies formed by the interaction of the carrier wave and the modulations composed of frequencies of the sum and difference of the modulating and carrying frequencies.

Side Band: Lower and Upper. See LOWER SIDE BAND and UPPER SIDE BAND.

Side Band Telephony. See SUPPRESSED CARRIER WAVE TELEPHONY, and SINGLE SIDE BAND TELEPHONY.

Side Bar Suspension (of a Traction Motor). A form of traction motor suspension in which almost the whole of the weight of the motor is carried by bars parallel to the

track and spring supported at one or both ends from the truck. Cf. NOSE SUSPENSION, etc.

Side Bracket Suspension. See SIDE POLE SUSPENSION.

Side Circuit. The name sometimes given to a telephone circuit which forms one of two, or more, employed for the superposition on them of a *Phantom Circuit*.

Side Contact Rail. A form of contact rail for electric railways in which the contact shoe bears horizontally on the side of the rail, so that the top can be more efficiently protected than in some other types.

Side Flashing. Sparks passing from a *Lightning Conductor* (particularly when not efficiently earthed) to neighbouring metal work.

Side Pole Suspension. The suspension of an overhead contact line from span wires or *Bracket Arms*, supported by poles at the sides of the track. Cf. CENTRE POLE SUSPENSION.

Side Rod Drive (of Electric Locomotives). An arrangement in which the driving wheels are driven through outside coupling rods and connecting rods from cranks on the motor shaft, or on a countershaft or *Jack Shaft* to which the motor or motors are geared.

Side Running Trolley. A trolley trolley with a swivelling head which can make contact with a line over the side of the track.

Side-Slot. The open slot in a conduit system of traction where the slot is in or outside one of the running rails.

Side-Tone. The reproduction by a telephone receiver of sounds falling on the microphone at the same station, where the connections are such that the current from the secondary of the induction coil or transformer passes through the receiver.

Side-Tone Reduction Wiring. A method of wiring *Central Battery* subscribers' telephone sets with the microphone between the switch hook and the induction coil to eliminate the effect of the condenser produced in *Side-Tone Wiring*.

Side-Tone Wiring. The method of

wiring *Central Battery* subscribers' telephone sets with the microphone between the line and the switch-hook in which the charging and discharging of the condenser, with the variation of the primary current, intensifies the *Side Tone* effect. Cf. *SIDE-TONE REDUCTION WIRING*.

Side Waves. See *SIDE BAND*.

Siemen. A name at one time proposed for a unit of energy equal to one *Watt Hour*, and later as the unit of conductance (see *MHO*). Cf. *KELVIN*.

Siemens Automatic Telephone System.

A system of automatic telephone exchange working in which a *Pre-selector*, actuated when a subscriber lifts his receiver, first connects a free *Line Selector* to his line, which automatically connects to the line corresponding to the series of current impulses sent by the manipulation of the subscriber's dial switch. The preselector, which is the chief distinguishing feature of the system is driven by an alternating current from a special generator.

Siemens Electrodynamometer. An instrument of the *Dynamometer* type for current or power measurement, consisting of a fixed coil in a vertical plane surrounded by a swinging coil in a vertical plane at right angles to it in the zero position, controlled by a spring attached to a torsion head. When current passes through both coils they tend to become parallel, but the swinging coil is brought back to zero by the torsion head through the spring; the force between the coils being thus measured by the deflection of the pointer attached to the torsion head. In the case of current measurement, the coils are in series and the current is proportional to the square of the reading. In the wattmeter instrument the swinging coil is of high resistance and is across the voltage, and the watts are proportional to the reading.

Siemens "H" Armature. See *SHUTTLE-ARMATURE*.

Siemens Unit (*Siemens Einheit*). A unit of resistance proposed in 1880, in Germany, but now obsolete, being that of a column of mercury 1 metre long and 1 sq. mm. in

cross section at 0° C.; equal to 0.9407 *International Ohm*.

Signal: Audible Ringing, Clearing, Pilot, Submarine, and Supervisory. See *AUDIBLE RINGING SIGNAL*, *CLEARING SIGNAL*, etc.

Signal Lamp. An incandescent or other lamp caused to change its appearance by the movement of screens or coloured glasses, as in railway signalling; or a lamp which indicates certain conditions by its illumination and extinction, e.g. the signal lamps on telephone switchboards.

Signal Lamp Relay. A relay controlling the circuit of a signal lamp so that it lights up when certain conditions are realised.

Signal Lift Control. A system of control in which the car is started by push buttons (or car switch) and stopped at the desired floor by means of buttons on the landing or in the car.

Signal Motor. A small electric motor which actuates a semaphore or other railway signal.

Signal Strength (in *Wireless Telephony*). A term used by wireless engineers to signify the strength of a received signal produced by a transmitter at a particular distance, as measured by the component of e.m.f. induced in the aerial by the modulations, expressed in millivolts per metre of effective height. Cf. *FIELD STRENGTH*.

Signal Strength Meter. An apparatus consisting of a thermionic oscillator tuned to the incoming wave and connected to a potentiometer arrangement by which a known variable high frequency voltage can be applied to a receiving set and adjusted till the signal strength is the same as that when the aerial is connected.

Signalling: All-Electric, Automatic, Electropneumatic, and Harmonic Selective. See *ALL-ELECTRIC SIGNALLING*, *AUTOMATIC SIGNALLING*, etc.

Signalling Condenser. A condenser, used particularly in duplex telegraph systems, in parallel with a high resistance at the sending end of a line to improve the speed of working by having the effect of

applying the full voltage to the line while the current is growing, because the condenser acts as a short circuit to the resistance until it is fully charged. Cf. **READING CONDENSER**.

Signalling Key. A key used in *Line* or *Wireless Telegraphy* to control the sequence of the current impulses forming the signals. See references under **KEY**.

Signalling Network. See **FAULT-SIGNALLING NETWORK**.

Silencer. (1) An enclosing vessel to diminish the noise made by the spark in a wireless transmitting apparatus. (2) See **DEAFENER**.

Silent Discharge. A gradual and non-disruptive discharge of electricity from a conductor through the atmosphere, particularly where the atmosphere round the conductor is ionised. Such a discharge is sometimes accompanied by the formation of ozone. See **OZONISER**.

Silica Lamp. A mercury vapour or other discharge lamp in a silica tube.

Silica Valve. A *Thermionic Valve* in a silica bulb as in large transmitting valves.

Silicon Detector. A rectifier of electrical oscillations consisting of a piece of silicon in a particular crystalline state against a metal contact, which can be used in series with a telephone receiver as a wireless detector. See **CRYSTAL DETECTOR**.

Silk-Covered Wire. Wire covered with one or more layers of floss silk, superior to cotton-covered wire of small diameter on account of the thinner layer possible, less liability to retain moisture, as well as better appearance and better insulation for the same thickness of covering. Used for small magnet and instrument windings, etc.

Silurus. A kind of fish found principally in the Nile allied to the "cat-fish," capable of giving electric discharges physiologically, the direction of the current being from its head to its tail. Cf. **ELECTRIC EEL** and **TORPEDO**.

Silver Plating. The *Electrodeposition* of silver on metal objects, or those with a conductive coating. See

ELECTROPLATE, **ELECTROPLATING**, etc.

Silver Voltameter. An *Electrolytic Cell* used for the accurate measurement of the average current that has been passing during a given time, for the calibration of other instruments, etc., by weighing the amount of silver deposited on the cathode by the current from a solution of a silver salt. See **INTERNATIONAL AMPERE**.

Simms-Abady Photometer. A form of *Flicker Photometer* in which bevelled surfaces of a special shaped revolving disc, illuminated respectively by the standard and the source to be tested, are viewed alternately through an eyepiece, and the illumination of them is brought to equality so that the flicker disappears.

Simms-Edison Torpedo. See **TORPEDO**.

Simon Interrupter. An *Electrolytic Interrupter* in which the necessary high current density in the electrolyte is obtained by dividing the containing vessel into two portions by a porcelain partition with a small hole in it. Cf. **WEHNELT INTERRUPTER**.

Simple Catenary Suspension. See **SINGLE CATENARY SUSPENSION**.

Simple Rectification. See **ANODE BEND RECTIFICATION**.

Simplex Dialling. A system of *Dialling* using both conductors in parallel with earth return. Cf. **DUPLEX DIALLING**.

Simplex (Telegraph) System. A system in which single messages in one direction only at a time are sent. Cf. **DIPLEX**, **DUPLEX**, and **MULTIPLEX SYSTEMS**.

Simplex Winding. An armature winding containing only one path per pole following round the armature. Cf. **MULTIPLEX WINDING**.

Simplex Working (in *Wireless Telegraphy*). The use of the same aerial alternately for transmission and reception.

Simplexed Circuit. A telegraph circuit consisting of the two wires of a telephone circuit in operation in parallel with earth return. Cf. **COMPOSED CIRCUIT**.

Sine Current, Voltage, etc. An alternating current, voltage, etc.,

following a sine curve when its instantaneous values are plotted against time.

Sine Curve. A curve in which the sine of an angle is plotted vertically and the angle itself horizontally.

Sine Galvanometer. A form of galvanometer in which the coil and the scale are rotated after the needle has been deflected to bring it again to the zero. The current is then proportional to the sine of the angle through which the coil has been rotated. By this means a more sensitive coil arrangement can be employed than in the *Tangent Galvanometer*, as there is not the same necessity for uniformity of field.

Sine Meter. See REACTIVE VOLT-AMPERE-HOUR METER.

Sine Shaped, or Sine Wave, or Wave Form. The wave form of a *Sine Current* voltage, etc. Cf. PEAKED WAVE and FLAT TOPPED WAVE.

Sine Wave, Equivalent. See EQUIVALENT SINE WAVE.

Singing. A Thermionic Telephone Repeater is said to "Sing," or sometimes to "Howl," when, owing to unsuitable adjustment of its circuits, it acts as an oscillator, producing sustained oscillations of a frequency which causes an audible note to be produced in the telephones connected thereto.

Singing Arc. See DUDDELL ARC.

Singing Spark. A spark occurring at regular intervals of a frequency within the limits of audition, as obtained in *Quenched Spark* systems of wireless telegraphy; producing a singing note in the receiving telephone.

Single-Break Switch, etc. A switch, etc., in which the circuit is only opened at one point on each pole.

Single Cable or Single-Core Cable. A cable containing one core only. Cf. TWIN CABLE, TWO-CORE CABLE, etc.

Single Catenary Suspension. A form of *Catenary Suspension* in which a single bearer wire or cable and a single set of hangers are employed. Cf. DOUBLE CATENARY SUSPENSION.

Single Conductor Wiring. Wiring in which only one insulated conductor

is brought to each point, and the return is made through any earthed conductor, such as the hull of a ship.

Single Cross Span Suspension. A system of contact line suspension by single transverse span wires between poles or other structures. Cf. CATENARY CROSS SPAN SUSPENSION.

Single Current Key. A telegraph signalling key sending currents in one direction only. Cf. DOUBLE CURRENT KEY.

Single Current (Telegraph) System. A system employing currents in one direction only. Cf. DOUBLE CURRENT SYSTEM.

Single Feeder. A feeder which forms the only current path to the point in question. (Also called *Unit Feeder*.)

Single Fluid Cell. A cell in which both electrodes dip into the same electrolyte. Cf. DOUBLE FLUID CELL.

Single Lamp Transformer. A small transformer such as an *Adapter Transformer*, for enabling a low voltage lamp to be used on a circuit of higher voltage; proposed at the time when high efficiency metal filament lamps in small sizes could only be made for low voltages.

Single Layer Winding. An armature winding, usually of the *Barrel* type, in which each slot is occupied by a side of one coil only. Cf. DOUBLE LAYER WINDING.

Single Needle (Telegraph) System. A system in which the signals are made by the deflection, to one side or the other, of a vertical needle in the receiving instrument worked by a simple form of galvanometer. The signals can be read audibly to a certain extent from the sound of the needle hitting against its stops. See DOUBLE NEEDLE and FIVE NEEDLE SYSTEMS and INDUCED NEEDLE.

Single Potential (in Electrochemistry). See ELECTRODE POTENTIAL.

Single-Phase. A term characterising current, etc., or apparatus relating to the system of alternating current working, where a single alternating current in one pair of wires is employed in the ordinary way. Cf.

TWO-PHASE, THREE-PHASE, and POLYPHASE.

Single-Phase Alternator. An alternator giving *Single-Phase* current only. The armatures of single-phase alternators of modern design usually have only two-thirds of the slots provided with windings, particularly where a sine wave form is aimed at.

Single-Phase Commutator Motor. A motor for use with single-phase current, constructed on the same general lines as a direct current motor with a commutator, but with laminated field system as well as laminated armature. There are a number of ways of connecting the field and armature circuits, apart from the series and other arrangements, in which the windings are connected conductively; advantage may be taken of the fact that currents can be induced by the stator in the rotor, or vice versa, by a similar action to that of a transformer. See references under **SINGLE-PHASE MOTOR**, and cf. **POLYPHASE COMMUTATOR MOTOR**.

Single-Phase Current. A single *Alternating Current* in an ordinary two-wire circuit, unaccompanied by currents differing in phase therefrom in other branches of the circuit. Cf. **TWO-PHASE, THREE-PHASE, and POLYPHASE CURRENTS**.

Single-Phase Generator. See **SINGLE-PHASE ALTERNATOR**.

Single-Phase Induction Meter. An induction type meter for use on single-phase circuits requiring a phase-splitting device to obtain the necessary rotary field.

Single-Phase Induction Motor. A motor similar to an *Induction Motor* for polyphase circuits, but provided with arrangements for producing a rotary field for starting by a phase-splitting device, so that a current differing in phase from the main current passes through a portion of the rotor winding. When up to speed, however, the phase splitting device is out of use and the motor runs as an ordinary induction motor, the rotor following one of the two oppositely rotating fields into which the field produced

by the single-phase rotor can be considered as being composed.

Single-Phase Locomotive. A railway locomotive driven by single-phase traction motors and containing the necessary transformers and control apparatus, etc.; usually collecting current from a single overhead contact line at a high voltage, in some cases as much as 15,000 volts.

Single-Phase Meter. A meter for use on single-phase circuits, e.g. a *Single-Phase Induction Meter*.

Single-Phase Motor. A motor for use on single-phase circuits, of the *Single-Phase Induction* type, the *Synchronous* type, or one of the numerous types of *Single-Phase Commutator Motor*. See below.

Single-Phase Motor: *Compensated, Compensated Induction, Compensated Repulsion, Compensated Series, Doubly Fed, Inverted Repulsion, Neutralised Series, Repulsion, Series, Series Conduction, Series Induction-Conduction, Shunt Conduction, Shunt Induction, Singly Fed, Squirrel-Cage Repulsion, and Synchronous.*¹ See **COMPENSATED SINGLE-PHASE MOTOR, COMPENSATED INDUCTION MOTOR, etc.**

Single-Phase Railway. An electric railway employing single-phase currents in an overhead contact line, and *Single-Phase Traction* on the trains: having the advantages over three-phase working of a single contact line, and that a type of motor with good starting torque and range of economical speed control can be employed, and over direct current working that higher line pressures can be employed, without converting stations. The train equipment is, however, heavier and slightly less efficient. (In some early lines, converting plant and direct current motors were used on the train.

¹ The above are names used for the principal classes of single-phase motors. A very large number of types have been proposed and made which do not all fall exactly into any one of these classes. They are mostly known by their inventors' names. For particulars, reference must be made to specialised literature on the subject.

Cf. HIGH TENSION DIRECT CURRENT RAILWAY.

Single-Phase Series Motor. A *Single-Phase Commutator Motor* with the armature and field windings in series.

Single-Phase System. A system of distribution of electrical energy for power, traction, lighting, etc., employing single-phase current.

Single-Phase Traction. See SINGLE-PHASE RAILWAY.

Single-Phase Traction Motor. A *Traction Motor* suitable for running on single-phase systems, usually either of the *Series commutator* type (sometimes able to run on direct current as well), or of the *Compensated Repulsion* type with a characteristic similar to that of a series motor, usually controlled by application of a variable voltage from tappings on an auto-transformer carried on the train.

Single-Phase Transformer. A *Transformer* with a single magnetic circuit, one primary and one secondary winding, to transform single-phase current from one pressure to another. On three-phase systems, groups of three single-phase transformers are sometimes preferred to one *Three-Phase Transformer*.

Single-Phase Winding. A winding not divided into branches for current of phases differing relatively one from another.

Single-Pivot Instrument. See UNIPIVOT INSTRUMENT.

Single-Pole (S.P.) Cut-Out, Circuit-Breaker, Fuse, Switch, etc. A cut-out, etc., which opens the circuit at one pole only. Cf. DOUBLE POLE CUT-OUT, etc.

Single Potential (in Electrochemistry). See ELECTRODE POTENTIAL.

Single Side-band Telephony. A form of *Suppressed Carrier Wave* line in wireless *Telephony* in which one *Side Band* is filtered out as well as the carrier frequency to minimise the range of frequencies occupied.

Single-Stroke Bell. An electric bell not fitted with a *Trembler*, which therefore gives only a single stroke of the hammer on the gong when the current begins to flow independently of its duration.

Single-Throw Switch. A switch, usually of the *Knife* pattern, in which the moving contact, or set of contacts, if for more than one pole, makes contact with only one contact or sets of contacts. Cf. DOUBLE THROW SWITCH.

Single Touch. A method of magnetising a bar of steel by touching or stroking by one pole of a single magnet. Cf. DOUBLE TOUCH and DIVIDED TOUCH.

Single-Trolley System. Electric traction on tramways, etc., where a single overhead contact line and an earth return are used. Cf. DOUBLE TROLLEY SYSTEM.

Single-Turn Coil. An armature coil consisting only of a single turn, usually of rectangular section bar; preferable where possible to a coil of more turns, as giving better conditions of commutation.

Single-Turn Current Transformer. A term often applied to *Bar-Type Current Transformers*, although really the primary does not make a complete turn.

Single-Wave Rectification. See HALF-WAVE RECTIFICATION.

Single Wave-Length Working. The working of two separate broadcasting stations, e.g. *Relay Stations*, at the same wave-length. This requires very accurate frequency control and results in a rather limited service area round each station surrounded by a "Mush" area where interference spoils the signals of both; the service area is greater if the same programme is being broadcast.

Single-Way Switch. A switch arranged to open and close one set of contacts only. Cf. TWO-WAY SWITCH, etc.

Single-Wire System. (1) An installation in which an "earth" return is used, so that only one wire has to be brought to every lamp, etc., e.g. a ship lighting installation in which one terminal of every lamp, etc., is connected to the metal hull of the ship. (2) An installation in which all the apparatus concerned is connected in series, e.g. a *Closed Circuit* fire alarm system.

Single-Wound Armature. An armature carrying a winding consisting

of a number of turns all in series, from which tapings are taken to commutator segments at equidistant points, e.g. a *Gramme Ring*.

Singly Fed (Series or Repulsion) Motor. A single-phase commutator motor, the armature of which receives power wholly by conduction or wholly by induction. Cf. **DOUBLY FED MOTOR**.

Singly Re-entrant Winding. See **RE-ENTRANT WINDING**.

Sinoidal or Sinusoidal Current, Voltage, Wave, etc. An alternating current, etc., with a wave form following a true *Sine Curve*.

Sinusoidal Therapy. Curative application of ordinary alternating currents.

Siphon Recorder. An instrument introduced in its original form by Kelvin for recording messages received over long submarine cables; consisting essentially of a sensitive moving coil galvanometer with large field magnets and a glass siphon or pen deflected by the moving coil and moving over but not touching a travelling strip of paper. The ink is caused to flow freely from the capillary tube forming the pen by keeping it charged by a simple form of motor driven influence machine known as a *Moussé Mill*.

Six-Phase Currents. Currents in six interconnected branches of a circuit differing in phase symmetrically from one another. Used in the connection between the alternating side of rotary and mercury-arc converters, and the transformers serving them.

Six-Wire Three-Phase System. A three-phase system with separate wires for the lead and return of each phase; equivalent to a six-phase system.

Skate, Contact. See **CONTACT SKATE**.

Skeleton-Type Switchboard. A switchboard in which the component apparatus is mounted upon metal framework.

Skew Coil Winding. A form of *Two Range Winding* for *Three-Phase* alternator armatures similar to a *Chain Winding*, in which the coils are bent to a special shape to clear

each other and lie in two ranges of end connections and yet require only one pattern of coil throughout.

Skewed Slots. Slots set at an angle with the axial direction; sometimes used in induction motors, etc.

Skiagram and Skiagraph. See "X" **RAY PHOTOGRAPH**.

Skin Effect. The fact that at very high frequencies the current in a conductor is more and more confined to the surface owing to the screening effect of the eddy currents induced below the surface. This causes the impedance of solid wires, etc., to be materially higher at high than at low frequencies. See **HIGH FREQUENCY RESISTANCE**. Also called *Heaviside Effect*.

Skinderviken Button. A compact form of capsule of granulated carbon for microphones.

Skip Distance. The portion of the range of a wireless transmitting station where signals are weak as it is too great to reach by *Direct Rays* and not far enough for *Indirect Rays*, which would have to strike the ionosphere at too acute an angle to be totally reflected.

Skrivanoff Cell. A primary cell with zinc and silver electrodes and an electrolyte of caustic potash and silver chloride on the positive pole as a depolariser. Used at one time for small decorative lamps.

S.L. Cable. See **SEPARATE LEAD-COVERED CABLE**.

Slab Coil. An inductance coil, etc., in the form of a flat spiral.

Slaby-Arco System (of Wireless Telegraphy). An early form of the *Quenched Spark* system.

Slack Cable Switch. See **SLACK ROPE SWITCH**.

Slack Indicator. An apparatus used on cable ships for indicating and recording the percentage of slack with which a cable is payed out, by comparison between the amount of cable payed out and the amount of a tight steel wire payed out at the same time with as little slack as possible.

Slack Rope Switch (in Lift Control). A device for opening the control circuit and stopping the car, if one

rope becomes seriously slacker than another.

Sledge Coil. A secondary coil made so that it can slide over a primary coil, or *vice versa*, so that a variable inductive coupling can be obtained.

Sleeve (1) of a Telephone Plug. The metal sleeve forming one of the contacts round the shank of the plug. Cf. TIP and RING. (2) In conduit wiring. See PLAIN COUPLER.

Sleeve : Armature, Commutator, and Splicing. See ARMATURE SLEEVE, COMMUTATOR SLEEVE, etc.

Sleeve Joint. A joint in a conductor made by slipping a sleeve over it and attaching by soldering or otherwise. See TWISTED SLEEVE JOINT.

Slide, Thomson-Varley. See THOMSON-VARLEY COILS.

Slide-Back. Name given to an instrument used in control rooms of broadcasting stations to indicate the amount of grid current present in the modulating system so that it can be kept at a minimum to avoid distortion.

Slide-Base. A base fulfilling the same functions as *Slide-Rails*.

Slide-Rails. Rails upon which a belt driven dynamo (or a motor) is sometimes mounted, to permit of adjustment of the tightness of the belt by shifting the position of the machine to a slight extent.

Slide-Resistance. A resistance arranged so that more or less of it can be included in the circuit by adjustment of a sliding contact.

Slide-Wire. A bare stretched wire of uniform resistance which can be used as a continuously variable resistance, having a value proportional to the length up to a sliding contact.

Slide-Wire Bridge. A *Wheatstone's* or other *Bridge* in which the variable resistance arms are formed by a bare stretched wire, with any point along which contact can be made by a sliding contact, dividing it into two parts, the resistances of which are proportional to their length. See METRIC BRIDGE.

Sliding Contact. A contact piece arranged to make contact with any part of a slide wire resistance,

or with any one of a row of fixed contacts by being slid over them, or any contact piece with which there is relative movement with another while they are in contact.

Slings, Cable. See CABLE SLINGS.

Slip. The difference between the actual speed of an induction motor and the speed of the rotating field, i.e. the synchronous speed; usually expressed as a percentage.

Slip Conduit or Slip Joint Tubing. Conduit tube in which joints are made by slipping a sleeve of slightly larger diameter over the ends of the tubes, or by slipping one tube over another of smaller diameter.

Slip Joint Tubing. See SLIP CONDUIT.

Slip Power. The power wasted in resistance when a slip-ring induction motor, with rheostatic control, is running at a reduced speed.

Slip Regulator. An automatic regulator which inserts resistance into the rotor circuit of an induction motor, allowing it to slow down at times of heavy load, used particularly in connection with fly-wheel motor-generator sets for power equalisation where such reduction of speed permits of utilisation of the stored power in the flywheel, while it is enabled to run at higher speed again on light load to regain more stored energy. Slip regulators are also used in connection with induction motors driving *Rolling Mills*. See ILGNER SYSTEM.

Slip-Ring. A contact ring for making connection through brushes between a winding, etc., on a rotating part of a machine or apparatus and an external circuit, e.g. the field winding of a rotating field alternator and the exciter.

Slip-Ring Bush. A bush carrying a set of *Slip Rings* on the shaft of a machine.

Slip-Ring Induction Motor. An *Induction Motor*, the rotor of which is provided with a winding connected to slip rings for connection to a resistance for starting or running temporarily at a reduced speed. Cf. SQUIRREL-CAGE INDUCTION MOTOR.

Slip-Ring Phase Advancer. See PHASE ADVANCER.

Slip-Ring Rotor. The rotor of a *Slip Ring Induction Motor*. Cf. **SHORT-CIRCUITED ROTOR**.

Slip-Ring Spider. A structure with spokes, mounted on the shaft of a machine to carry the slip rings.

Slope (in a Thermionic Valve). The "slope" of that portion of the characteristic of a thermionic valve over which it works, i.e. the ratio of the change of plate current to the change of grid voltage causing it.

Slope, Potential. See **POTENTIAL GRADIENT**.

Slope Inductance. A term sometimes used in wireless telegraphy for the ratio of the change in flux-turns to the change of current causing it, in cases where the latter is small in comparison with the total, as in audio-frequency oscillations imposed on the plate current of a thermionic amplifier.

Slot. (1) An open, partly closed, or closed channel in the laminations building up the stator or rotor core of a dynamo electric machine, separated by the teeth formed by the portions of the sheets not punched out, for the reception of the conductors forming the winding. (2) The opening in the conduit of an open conduit tramway through which the conductors making connection between the car circuits and the underground conductors pass.

Slot: Armature, Closed, Half Closed, Milled, Open, Parallel, Partly Closed, Radial, Side, Skewed, and Taper. See **ARMATURE SLOT, CLOSED SLOT**, etc.

Slot Conduit. See **SLOTTED CONDUIT**.

Slot Leakage. The portion of the flux in a machine that passes across or down the slots instead of through the iron of the teeth.

Slot Lining. A layer of insulating material lining the slot, independent of the insulation with which the individual conductors and the groups of conductors forming the coils are covered.

Slot Meter. See **PREFPAYMENT METER**.

Slot Pitch. The circumferential distance apart of the centre lines of the slots, usually measured at the air gap.

Slot Ripples. See **TOOTH RIPPLES**.

Slot System (of Electric Traction). See **CONDUIT SYSTEM**.

Slot Wedge. A strip, usually of wood, inserted in the mouth of a slot after the winding is in place to retain it against centrifugal force, usually held in grooves in the side of the slot. Also called a *Key*.

Slot Wedge, Magnetic. See **MAGNETIC SLOT WEDGE**.

SloTTed Conduit. A conduit containing underground conductors for tramway systems, etc., in which connection is made with the car circuit through an open *Slot*. Cf. **CLOSED CONDUIT**.

SloTTed Core. An assemblage of laminations in which the winding is carried in slots. Cf. **SMOOTH CORE**.

SloTTed Core Armature. An armature in which the winding is contained in slots in the core. Cf. **SMOOTH CORE ARMATURE**.

Slow-Break Switch. A switch not fitted with any spring or other device to accelerate the break. Cf. **QUICK-BREAK SWITCH**.

Slow Cyclic Method (of Magnetic Testing). A method of magnetic testing in which a constant deflection is produced in the galvanometer connected to the search coil by varying the magnetomotive force at a measured rate by means of a special form of potential divider in the primary circuit. Cf. **BALLISTIC METHOD**.

Slow Motion Starter. A *Motor Starter* provided with mechanism such as a worm gear between the operating handle and the contact lever, or a dashpot or other retarding device, so that the starting resistance can only be cut out very slowly during starting.

Slowing Switch (in Electric Lifts). A switch operated by the travel of the car to cause it to slow down on reaching a certain point.

Sludge. A muddy deposit in transformer and switch oils, due to chemical action caused by oxidation, polymerisation, contact with copper, etc.

Slug. A metal sleeve or short-circuited winding carried on the case of a telephone or other relay, to retard its action.

Small Bayonet Cap (S.B.C.). A lamp cap of similar construction to, but of smaller size than, that described under *Bayonet Cap* (about $\frac{3}{8}$ in. diam.); used for candle lamps, automobile lamps, etc.

Small Calorie. See CALORIE.

Small Central Contact (S.C.C.) Cap. A lamp cap of similar construction to, but of smaller size than, that described under *Central Contact Cap* (about $\frac{3}{8}$ in. diam.).

Small Edison Screw (S.E.S.) Cap. A lamp cap of similar construction to, but of smaller size than that described under *Edison Screw Cap* (about $\frac{1}{2}$ in. diam.).

Smee Cell. An early form of single fluid cell with electrodes of zinc and platinised silver in an electrolyte of dilute sulphuric acid, the latter of which was found to give off the bubbles of hydrogen more freely than copper and thus to suffer less from *Polarisation*.

Smelting (Electric). The reduction of metals from their ores either in the *Electric Furnace* or electrolytically without a high temperature.

Smoke Deposition (Electrical). An experimental method of avoiding visible smoke from chimneys by causing the solid particles to be precipitated by a high tension discharge across the mouth of the chimney. See also PRECIPITATION.

Smooth Core Armature. The old-fashioned form of direct current armature, without slots, in which the windings were placed upon the surface, held down by bands, and prevented from shifting sideways by wooden pegs. Cf. SLOTTED ARMATURE.

Smooter. See SMOOTHING CIRCUIT.

Smoothing Choke. An inductor used in a *smoothing circuit*.

Smoothing Circuit. A combination of capacitance and inductance for filtering out ripples in an ordinary direct current supply voltage, or a rectified alternating voltage to enable it to be used for the anode circuit of a thermionic valve or similar purposes. A condenser alone is sometimes sufficient, and is referred to as a *Smoothing Condenser*.

Smoothing Condenser. See SMOOTHING CIRCUIT.

Snap Switch. A small *Quick Make and Break Switch*, such as a branch switch in a lighting installation controlling a few lamps.

Sneak Current. A term used in telephone engineering for leakage currents from power circuits, etc., through telephone circuits which, although too weak to do immediate damage, may produce harmful heating effects if allowed to continue for an extended period; guarded against by *Heat Coils*.

Snook Rectifier. A revolving four-arm rectifying switch driven by a synchronous motor for obtaining a high unidirectional voltage from an A.C. transformer for working "X" Ray Tubes.

"Snow" Rule. The rule regarding the direction of the deflection of a magnetic needle which states that, if the current flows from South to North Over the needle, the North Pole of it will be deflected to the West.

Snyder Furnace. A form of direct arc furnace for steel manufacture.

Soaking In. The gradual increase of the charge in a condenser above its initial value if the application of the potential is continued, due to a change in the dielectric.

Soaking Out. The gradual continuation of the discharge of a condenser after its first immediate discharge, as the dielectric reverts to its original state. Cf. RESIDUAL CHARGE.

S.O. Cable. A type of three-core cable without sufficient filling material to make it circular, and thus having a section which is triangular, with rounded corners. Claimed to be lighter, easier to manufacture, and of better thermal characteristics than circular cable.

Socket. A receptacle into which a plug is inserted to make contact, e.g. a wall socket for the reception of a plug to which a flexible cord for a portable lamp, etc., is attached.

Socket : Cable, Coupler, Lamp, and Switch. See CABLE SOCKET, COUPLER SOCKET, etc.

Socket Outlet. See **Socket**.

Socket Outlet, Pendant. See **PENDANT SOCKET OUTLET**.

Socket Outlet Adapter. A device for insertion into a socket outlet with provision for the reception of more than one plug.

Sodium Discharge Lamp or Sodium Vapour Lamp. A *Gas Discharge Lamp* of high efficiency containing a certain amount of sodium vapour in the tube, giving a yellowish light.

Soederberg Electrode. See **SELF-BAKING ELECTRODE**.

Soft Iron Instruments. See **MOVING IRON INSTRUMENTS**.

Soft Photoelectric Cells. Photoelectric cells having a certain amount of residual gas left in the bulb. More sensitive than "hard" cells, but less reliable for photometric purposes.

Soft Radiation. A term sometimes used for radiation of wave-length intermediate between the ordinary range of "X" Rays and ultra-violet "light."

Soft Tubes. Discharge tubes, such as "X" Ray Tubes, are said to be soft when the vacuum is only moderately high, i.e. of the order of two millionths of an atmosphere. A soft "X" ray tube gives less penetrating rays than a *Hard Tube*.

Soft Valve. A thermionic valve with only a moderately high vacuum, even as low as 1/1,000 atmosphere, and depending upon gaseous ions rather than free electrons; less stable than a *Hard Valve*, and more suitable as a detector than for other purposes.

Soft "X" Rays. "X" rays of poor penetrating power, i.e. comparatively long wave length. Cf. **HARD "X" RAYS**.

Solari Coherer. An early form of *Coherer* consisting of a drop of mercury between iron electrodes.

Soldered Joint. A joint in which the conductors are soldered together as is usually done with copper, but not with aluminium. Cf. **MECHANICAL JOINT**.

Soldering Iron (Electric). A soldering iron provided with a heating resistance in its interior by which it can be kept at a suitable temperature for continuous working.

Solenoid. A helical coil of wire of one or more turns, carrying a current but without a fixed iron core; showing all the properties of an electromagnet and sometimes used to attract a moving iron plunger in cases when a considerable range of movement is required.

Solenoid Blow Out. A magnetic *Blow Out Coil* without an iron core.

Solenoid Brake. A tramcar or other brake actuated by the attraction of an iron plunger into a *Solenoid*, or a crane or lift brake actuated by weights of springs but released during the working of the motor by a solenoid.

Solenoid Controller or Starter. A controller or starter, such as that of a lift, actuated by the pull of a solenoid on a plunger, often against a dashpot, in order to ensure that the resistances are cut out slowly.

Solenoid Relay. A *Relay* in which the local contacts are closed through the pull of a solenoid on a plunger.

Solenoid Switch, Starter, etc. A remote controlled switch, starter, etc., operated by the pull of a solenoid on a plunger.

Solenoidal Inductor. A long uniformly wound coil of accurately known dimensions, with a small search coil or secondary winding at its centre, for calibrating ballistic galvanometers by observing the throw produced by the reversal of a known current.

Solenoidal Magnetisation. See **CIRCUITAL MAGNETISATION**.

Solid Back Microphone. A microphone telephone transmitter of a type in which two flat carbon discs, one attached to the diaphragm and the other to the solid back of the case, are used with granulated carbon between them.

Solid Carbons. *Arc Lamp Carbons* without a core of softer material in the centre. Cf. **CORED CARBONS**.

Solid Conductor. A conductor not divided into strands.

Solid Cored Carbons. *Cored Carbons* in which the core consists of a solid rod, either pure or impregnated, instead of a filling of soft paste.

Solid Electrolyte. A solid substance which is chemically decomposed by

the passage of a current. The term is also used for the gelatinous electrolyte employed in portable accumulators for wireless sets, etc.

Solid End (of a Cable). A sealed or capped end in which the cores are soldered to the cap.

Solid Pole. A pole in a dynamo-electric machine, etc., which is not *laminated*.

Solid System (of Cable Laying). (1) A system in which the cables are laid in troughing of wood, stoneware, asphalt, iron, etc., which is afterwards filled in with a fusible substance such as bitumen. (2) Of insulation: A system employed in *Metal Clad Switchgear*, cable boxes, etc., in which all the spaces between the conductors and the metal covers are filled with solidified compound.

Solidly Earthed System. A distribution system in which the earth connection is at very low resistance.

Solomon's Unit. A unit of "X" Ray quantity used in France, having a value of about 2.29 *Röntgen*.

Solution Voltage, Electrolytic. See *ELECTROLYTIC SOLUTION VOLTAGE*.

Sonic Frequency. See *AUDIO FREQUENCY*.

Sonometer. A frequency measuring instrument depending upon mechanical resonance with the vibrations of a variable length of a stretched wire.

Sound Analyser (Electrical). An apparatus for measuring and analysing sounds, consisting of a microphone, an amplifier, and a means of measuring the complex wave form of its output, such as an oscillograph or a frequency analyser with tuned circuits for dealing with each harmonic separately.

Sound Film. A cinema film for simultaneous reproduction of speech, music or other sound effect; asynchronously with the action usually depicted. In most systems the sound vibrations are recorded photographically on the edge of the film itself. A beam of light is modulated according to the original sound waves by a microphone and amplifier and imprints a variable trace on the film, while

it is being passed through the camera. This, when the positive film is being projected, produces similar modulations in a beam of light which fall on a *Light Sensitive Cell* and causes the required modulations of the current in the amplifier circuit of the loud speaker.

Sound Recording, Magnetic. See *MAGNETIC SOUND RECORDING*.

Sounder. A telegraph receiving instrument in which the attraction of an armature by an electro-magnet makes an audible sound as it hits against its stops at the beginning and end of each current impulse, and permits of the message being read in the Morse or other code by ear.

Sounder: Double Current, Double Plate, Morse, Polarised, and Relaying. See *DOUBLE CURRENT SOUNDER*, *DOUBLE PLATE SOUNDER*, etc.

Sounding: Echo, Reflection, and Supersonic. See *ECHO SOUNDING* and *REFLECTION SOUNDING*.

Sourdane. See *DEAFENER*.

South, Magnetic. See *MAGNETIC SOUTH*.

South Pole. (1) Of the earth: either the true geographical South Pole, or the *Magnetic South Pole*. (2) Of a magnet: the pole which tends to point towards the south when freely suspended, i.e. the *South Seeking Pole*.

South Pole, Magnetic. See *SOUTH POLE*.

South Seeking Pole. See *SOUTH POLE*.

S.P. Usual abbreviation for *Single Pole*, when specifying switches, etc.; sometimes also used for *Single Phase*.

Space: Crookes' Dark, Faraday's Dark, Interferic, and Winding. See *CROOKES' DARK SPACE*, *FARADAY'S DARK SPACE*, etc.

Space Charge. The electric charge in the space between the electrodes in a thermionic valve due to the presence of free ions or electrons.

Space-Charge Grid. See *Space-Charge Grid Valve*.

Space-Charge Grid Valve. A *Thermionic Valve*, provided with an extra inner grid, maintained at a fixed potential, having the effect

of reducing the anode resistance of the valve by counteracting the space charge near the filament.

Space Current. The current through a *Thermionic Valve* due to the passage of the projected electrons towards the anode.

Space Factor. The ratio of the actual cross section of the conductors in a winding to the cross section of the total space occupied, including insulation and clearance.

Space Rays. See *INDIRECT RAYS*.

Space Telegraphy and Telephony. Another name for what is commonly called *Wireless Telegraphy and Telephony*.

Spaced Aerial. An aerial system used in receiving stations for short waves, in which a number of separate aeriels at considerable distances apart are employed to minimise the local effect of fading.

Spaced Aerial Direction Finder. See *ADCOCK DIRECTION FINDER*.

Spacing Current. The current which flows between the impulses forming the signals in the Morse or similar code, in systems where the signalling is effected by some change in the magnitude or direction of the current and not by its interruption. Cf. *MARKING CURRENT*.

Spacing Ratio. A term used in illuminating engineering for the ratio of the distance between equally spaced lamps to their height above the working plane.

Spacing Waves. The waves radiated between these forming the signals of the Morse or similar code, in systems where the signalling is effected by a change in amplitude or frequency of the continuous waves employed.

Spade Tuning. A rough-and-ready method of tuning wireless receiving apparatus by moving a flat metal "spade" over the face of a flat coil to alter its effective inductance.

Span. The distance between supports in overhead lines. Cf. *DIP* or *SAG*.

Span, Polar or Pole. See *POLE SPAN*.

Span-Wire Suspension. The suspension of overhead contact lines for tramways, etc., by ears attached to transverse "span wires," the

ends of which are supported either by poles at the sides of the track or from rosettes on neighbouring buildings.

Spark (Electric). A momentary flash due to an electric discharge through air or other insulating material. See also *SPARKING*.

Spark : Active, Arcing, Break, Disruptive, Jump, Make, Musical, Pilot, Quenched, Singing, Timed, Trigger, and Wipe. See *ACTIVE SPARK, ARCING SPARK, etc.*

Spark Coil. An *Induction Coil* for the production of spark discharges.

Spark Counter. An instrument for ascertaining by a photographic record, or otherwise, the spark frequency in a wireless transmitter or other apparatus.

Spark Discharge. See *DISRUPTIVE DISCHARGE*.

Spark Frequency. The frequency with which the sparks occur in a wireless transmission apparatus on the spark system, i.e. the *Group Frequency* of the trains of waves and not of the waves themselves.

Spark Gap. The space between two electrodes provided for a *Disruptive Discharge* to pass across without establishing an arc.

Spark Gap : Asynchronous, Auxiliary, Protective, Quenched, Rotary, and Synchronous. See *ASYNCHRONOUS SPARK GAP, AUXILIARY SPARK GAP, etc.*

Spark Micrometer. A *Spark Gap* the length of which can be adjusted and determined accurately by a screw with graduated head, for investigation of sparking distances for different voltages and forms of electrode, or the approximate measurement of high voltages for which the sparking distance with the terminals in use are known. See *SPARKING DISTANCE*.

Spark Photography. (1) Photography of rapidly moving objects, e.g. flying bullets, by illuminating them suddenly with the light from a single electric spark. (2) Photography of sparks themselves by their own light.

Spark Recorder. A recording instrument in which the record is made by periodical sparks from an

induction coil, passing from the tip of the pointer to the drum and leaving a small hole in the paper thereon, and thus avoiding the friction of a pen upon the paper.

Spark Resistance. The actual resistance in ohms offered by the spark gap when the spark is occurring; varying with the current passing practically with a straight line law; of importance in calculating the decrement in an oscillating circuit containing a spark gap. See LINEAL DECREMENT.

Spark System of Wireless Telegraphy.

A system of wireless telegraphy in which successions of short trains of damped waves, obtained from oscillations provoked by a succession of spark discharges in a suitable circuit; e.g. the earlier forms of the *Marconi System*, and the systems employing the *Quenched Spark*. See SHOCK EXCITATION.

Spark Transmitter. A wireless transmitting apparatus employing a spark discharge as the source of the oscillations. (See above.) Cf. ARC TRANSMITTER and VALVE TRANSMITTER.

Sparking. Any exhibition of spark discharges, either intentional or accidental; more particularly that produced by breaking a more or less inductive circuit, e.g. between the contacts of switches, contact breakers, etc., or between the brushes of a dynamo, etc., and the commutator, if the short circuit of two adjacent segments is opened at a moment when there is an e.m.f. in the coil between them, i.e. when *Commutation* is not complete. Such sparking is not only injurious to the contact surfaces, but in coal mines may become a source of danger by ignition of inflammable gases. See FLAME-PROOF.

Sparking, Open. See OPEN SPARKING.

Sparking Coil. See SPARK COIL.

Sparking Contact. See AUXILIARY CONTACT.

Sparking Distance. The maximum length of an air gap across which sparks will pass at a given voltage under given conditions, depending

on the wave-form of the applied voltage, the form of the electrodes, the nature, temperature, and pressure of the medium, and the amount of light falling upon the electrodes (because ultra-violet rays have the power of causing partial ionisation of the medium). The connection between sparking distance and voltage is, however, sufficiently known in air at ordinary temperatures and pressures between needle point electrodes to render the spark length a useful rough indication of voltages of from, say, 10,000 to 300,000 volts.

Sparking Limit. The limit of output which a machine can deal with without injurious sparking at the commutator; lower in some cases than the *Thermal Limit* of the machine.

Sparking Plug. A plug for screwing into an aperture in the cylinder head of an internal combustion engine provided with conductors forming a spark gap within the cylinder, at which a spark is made to pass at the moment when ignition of the charge is required; usually with one electrode carried by a conductor passing through a porcelain, or other insulating sleeve, to an outside terminal, while the other conductor is in connection with the metal of the engine. For *Low Tension Ignition* systems, the plug contains mechanical arrangements whereby a contact can be made and broken within the cylinder. See IGNITION and MAGNETIC PLUG.

Sparking Voltage. The minimum voltage at which a spark discharge can be produced between electrodes of given form at a given distance apart under given conditions. See SPARKING DISTANCE.

Sparkless Commutation. The running of a machine entirely without sparking at the commutator.

Spark-Over Test. A test to determine the *Spark-Over Voltage* of an insulator under specified conditions.

Spark-Over Test : Dry, Impulse, and Wet. See DRY SPARK-OVER TEST, IMPULSE SPARK-OVER TEST, etc.

Spark-Over Voltage. That voltage at which a given insulator, etc., allows a spark discharge to pass round it, under specified conditions.

Sparklet Fuse. A fuse provided with one or more little steel reservoirs of compressed carbonic acid which are opened when the fuse blows, by the fusing of a plug with which each is sealed, so that a powerful blast is produced to blow out the arc.

Speaking Arc. An arc which has modulations from a telephone circuit, superposed upon the current through it. These cause it not only to emit sounds reproducing the original speech but to vary the light emitted correspondingly, so that it can be used for *Photophone* and *Sound Film* purposes. See also **DUDELL ARC**.

Speaking Clock. A clock provided with apparatus similar to that used in sound film projection to repeat the time in spoken words at frequent intervals so that telephone subscribers can ascertain the correct time by making the necessary connection.

Speaking Current. The *Audio-Frequency* current which actuates a telephone receiver as distinct from the currents for signalling, etc., in a telephone circuit.

Speaking Film. See **SOUND FILM**.

Speaking Key. A key at an operator's position at a telephone exchange switchboard which enables the operator to make connection between a particular line and her own instrument, in order to speak to a subscriber.

Spear, Battery. See **BATTERY SPEAR**.

Specific Conductance or Specific Conductivity. The conducting power of a material in *Mhos* per centimetre cube, i.e. the reciprocal of *Resistivity*.

Specific Consumption (of an Incandescent Lamp). A term to be preferred to *Efficiency* for the description of the energy, in watts, consumed per candle power emitted.

Specific Damping (of a Telephone Cable). The *Attenuation Constant* per kilometre.

Specific Dielectric Strength. The *Dielectric Strength* per millimetre thickness of an insulating material. See also **BAUR'S CONSTANT**.

Specific Inductive Capacity. The name originally given by Faraday to the degree to which a material permits of electrostatic induction through it; measured by the ratio of the capacitance of a condenser with that material as dielectric to one of identical dimensions with a vacuum as a dielectric, i.e. what is now called *Permittivity*.

Specific Ionic Mobility. The degree of mobility of the ions in a substance measured by the conduction of 1 gramme-ion between electrodes 1 cm. apart.

Specific Magnetic Resistance. A term sometimes used for *Reluctivity*.

Specific Output. The ratio of the output of a machine to its weight, or to a certain function of its dimensions, such as d^2/l , where d and l are the diameter and length respectively of the armature core.

Specific Power Loss (of a Dielectric). The power loss per cubic centimetre for a voltage gradient of one volt per centimetre.

Specific Reluctance. See *Reluctivity*.

Specific Resistance. The *Resistance* of a material per unit length of unit cross section, usually expressed in microhms per centimetre cube. A preferable name is *Volume Resistivity*; usual symbol: ρ (Greek "rho").

Specific Temperature Rise. The temperature rise of a machine or apparatus per watt carried, per unit of radiating surface; usually after running a sufficient time for steady temperature conditions to be attained.

Specific Thermal Resistance. See **THERMAL RESISTIVITY**.

Specific Utilisation Coefficients. Two coefficients relating to what has been called the *Electric Loading* and the *Magnetic Loading* of a machine, giving respectively the watts out of the machine per pound of copper and per pound of iron.

Spectrograph, Mass. See **MASS SPECTROGRAPH.**

Spectrometer : "X" Ray (or Röntgen Ray). See "X" RAY SPECTROMETER.

Spectrophotometer. A *Photometer* for making comparisons between the luminous intensity of two sources at any definite point in their spectrum.

Spectrum: Beta (β) Ray, Characteristic Magnetic, Mass, Negative, and "X" Ray. See **BETA (β) RAY SPECTRUM, CHARACTERISTIC SPECTRUM, etc.**

Specular Reflection Factor. See **REGULAR REFLECTION FACTOR.**

Speech Amplifier. A *Low Frequency Amplifier* in *Wireless Telephony*.

Speech Frequency. See **VOICE FREQUENCY** and cf. **AUDIO FREQUENCY.**

Speech Inverter. Apparatus employed in *Suppressed Carrier Wave Single Side Band Telephony* which results in the high and low speech frequencies being interchanged, rendering the speech unintelligible if picked up without replacing the carrier wave. Cf. **SCRAMBLER.**

Speech Modulated Continuous Waves. Continuous waves, modulated in accordance with the vibrations produced by the sound waves of speech, as employed in wireless telephony. (Sometimes called *Type A3 Waves*.)

Speech Restorer. Apparatus at the receiving end of a *Suppressed Carrier Wave* telephone system the inverted speech received to its original frequencies.

Speed : Critical, Ionic, Signalling, Synchronous, and Working. See **CRITICAL SPEED, IONIC SPEED, etc.**

Speed Adjusting Rheostat. A rheostat of any kind for adjusting the speed of a motor, suitable for running for prolonged periods on any stop.

Speed Control. The regulation of the speed of a motor according to requirements by series or shunt resistance, by the application of a variable voltage, by alteration of connections, e.g. from series to parallel or from star to mesh, or by the number of effective poles,

or by other special means according to the type of motor employed.

Speed Control : Brush Shifting, Cascade, Krämer, Multivoltage, Pole-Changing, Rheostatic, Scherbius, Series-Parallel, Spinner, Variable Voltage, and Ward Leonard. See **BRUSH SHIFTING CONTROL, CASCADE CONTROL, etc.**

Speed Indicator : Eddy Current, Magneto, and Resonance. See **EDDY CURRENT SPEED INDICATOR, and MAGNETO SPEED INDICATOR.**

Speed of Transmission. Rate of telegraphic signalling, usually expressed in number of five letter words per minute; in an unloaded cable, roughly inversely proportional to the capacitance, the resistance and the square of the length.

Speed Regulating Rheostat. See **SPEED ADJUSTING RHEOSTAT.**

Speed Regulation. See **SPEED CONTROL.**

Speed Regulator. Any apparatus for varying the speed of a motor, e.g. a *Shunt Rheostat*.

Speed Torque Characteristic. A curve showing the relation of the speed of a motor and the torque it produces.

Sphaerophone. An electrical musical instrument in which the frequency is controlled by a variable capacitor.

Sphere of Coition or Sphere of Influence. Terms used by Gilbert and other early writers for magnetic or electric field.

Sphere Gap. A spark gap with spherical electrodes.

Sphere Gap Voltmeter. An instrument for measuring high voltages by observing the distance apart of two spherical electrodes, between which a spark will just pass in air.

Sphere Photometer. See **ULBRIGHT GLOBE PHOTOMETER.**

Spherical Armature. A form of armature practically spherical in shape, used in the early Thomson-Houston Arc-lighting Machines, fitting into the hollowed out pole-faces.

Spherical Candle Power. See **MEAN SPHERICAL CANDLE POWER.**

Spherical Reduction Factor. The ratio of the *Mean Spherical Candle Power* of a lamp to the *Mean*

Horizontal Candle Power. Used in connection particularly of incandescent lamps, and varying considerably according to the arrangement of the filament. (Also called *Reduction Factor of the Mean Spherical Intensity*.)

Sphygmograph (Electrical). An apparatus for recording electrically the action of the pulse; usually with the recording instrument at a distance from the patient.

Sphygmophone. A special form of microphone for attachment to the wrist to render the sound of the pulse clearly audible in a telephone receiver.

Spider: Armature, Commutator, Field, and Slip Ring. See ARMATURE SPIDER, COMMUTATOR SPIDER, etc.

Spill Current. A term used in connection with protective systems for the current due to the difference in the magnetising currents of two current transformers in opposition which, in certain circumstances, can cause a false operation of relays.

Spindle, Armature. See ARMATURE SPINDLE.

Spinner Motor. An *Induction Motor* in which the portion carrying the primary winding is free to rotate, as well as that carrying the secondary. At starting, the member not connected to the driven shaft is free and runs up to speed relatively to the other in the ordinary way without load. A brake is then applied, causing it to slow down and, keeping the relative speed between the two members the same, it gradually picks up the member attached to the load and brings it up to full speed. Another form of Spinner Motor has the free member carrying two windings and intermediate between the rotor and stator, forming the equivalent of two induction motors. Various running speeds can be obtained by adding or subtracting the relative speeds between the spinner and the two stationary portions, or using the inner motor only by locking the spinner.

Spinner Speed Control. See SPINNER MOTOR.

Spinthariscopes. An instrument for demonstrating radio-activity in which a fragment of radium is mounted in front of a fluorescent screen which continuously emits flashes owing to its bombardment by alpha rays.

Spintharometer. See SPARK MICROMETER.

Spiral, Roget's Dancing. See ROGET'S DANCING SPIRAL.

Spiral Coil. A coil in which each turn lies within the next without overlapping. Strictly applying only to coils in which the turns lie in the same plane, but also applied to armature coils, etc., in which the above is the case.

Spiral Connection. A form of *Butterfly Connection* for connecting armature conductors under adjacent poles in which the halves of the connections are of spiral form.

Spiral Winding. An obsolete name for a *Two-Circuit or Wave Winding*.

Splash-Proof. See WEATHERPROOF.

Spliced Conductor Rail. A length of conductor rail with a barbed end, for use at crossings, etc.

Spliced Joint. A cable joint in which the separate strands of the two parts of the core are entwined and twisted after the manner of splicing a rope.

Splicing Chamber. See JOINTING CHAMBER.

Splicing Sleeve. A tinned copper sleeve which is drawn tightly over the ends of two wires or cables to be jointed, for the whole to be made into a solid soldered joint.

Split Anode Magnetron. A *magnetron* used as a high frequency oscillator in which the cylindrical anode surrounding the cathode filament is divided longitudinally into halves between which oscillations are produced.

Split Conductor Cable. A cable in which each conductor is composed of more than one separately insulated path normally connected in parallel.

Split Conductor Protective System. A system for the automatic isolation of faulty feeders in which each of the two circuits in a split conductor cable is taken through a current transformer winding,

connected so that the two equal currents balance each other; but inequality, due to a fault, produces a flux in the transformer and actuates a relay connected to its secondary which trips the main circuit-breaker. Also known as *Merz-Hunter System*.

Split Conduit Fittings. *Bends, Ties,* etc., made in halves so that they can be put in place after the wires are in the conduits.

Split Electromagnet Instruments. An instrument of the electromagnetic type, the magnetic circuit of which can be opened out like tongs and closed round the conductor carrying the current to be measured.

Split Frame. A stator frame made in two parts, bolted together for convenience in lifting out the armature or rotor, without having to remove the bearings.

Split Order Wire Circuit. A circuit containing several *Order Wire circuits* from one operator's position.

Split Phase. See PHASE-SPLITTING DEVICE.

Split Phase Motor. See SINGLE-PHASE INDUCTION MOTOR.

Split Pilot Protective System. A development of the *Merz-Price System* in which two of the pilot wires are employed in a similar way to the two lines in a *Split Conductor System*.

Split-Pole Rotary Converter. A *Rotary Converter* in which the poles are divided into sections, the polarity of which can be reversed independently. By this means the effective pole arc can be altered, and the ratio of the commutator voltage to the slip ring voltage varied, within certain limits, to effect voltage regulation on the direct current side.

Spontaneous Radiation. A term sometimes used for the "X" Rays of characteristic atomic frequencies given off by an anti-cathode of a particular material, in addition to the so-called *Impulse Radiation* of continuous spectrum.

Spool. A term originally meaning the tube with flanges, upon which a coil such as that of an electromagnet is wound, but sometimes

used for the coil itself, whether wound with or without such a support. Cf. FORMER.

Spool, Field. See FIELD SPOOL.

Spool Winding. A winding in which the separate coils are wound on *Spools*.

Spot Lamp. A projector producing a narrow beam.

Spot Light Scanning. A method of *Scanning* used in *Television* in which a beam of light controlled by moving lenses, mirror or slotted discs is caused to illuminate every part of the object in rapid succession, and the variation of light reflected therefrom causes modulation in the output of photo-electric cells. Cf. ICONOSCOPE.

Spot Lighting. Lighting of special objects or areas by projectors producing comparatively narrow beams to produce a much higher degree of illumination than on the surroundings.

Spot Welding. A resistance method of welding sheets, etc., by passing current through the two surfaces lapping one over the other from electrodes which hold them tightly in contact, and repeating the process at regularly spaced intervals, so that the sheets are welded together at a number of "spots," instead of by a continuous joint as in *Seam Welding*; having a similar effect to a riveted joint. See also BUTT WELDING.

Sprague Control System. The first practically used system of *Multiple Unit* train control, dating from 1897, and employing drum type series-parallel controllers actuated by pilot motors.

Spray Arrester. A sheet of glass or other material placed over the top of an open accumulator cell to prevent splashing up of acid spray.

Sprayed Lamp. An incandescent lamp with a bulb sprayed with a white or coloured diffusing material.

Spread (of Winding). The angular distance occupied by that section of the armature winding under one pole which belongs to one phase. See SPREAD FACTOR.

Spread Factor. The factor by which the voltage that would exist in one phase of an alternator armature,

if all the winding of that phase were in one slot, has to be multiplied to allow for the "spread" of the winding over several slots owing to the difference in phase of the e.m.f. in them.

Spreader. (1) An apparatus which opens out flat former-wound armature coils into the required diamond shape. (2) A crossbar used to keep two wires forming an aerial parallel to one another.

Spreading Coefficient. See FRINGING COEFFICIENT.

Spring Control. The provision, in measuring instruments, etc., of a controlling torque against the torque due to the action of the current, etc., by means of springs. Cf. GRAVITY CONTROL.

Springs: Brush, Contact, Impulse, Protector, and Switch. See BRUSH SPRINGS, CONTACT SPRINGS, etc.

Spurious Resistance. The ratio of the impressed voltage to the current which it produces in a part of a circuit where there are other causes than resistance to affect the flow of current, such as *Reactance* or *Counter-E.M.F.*

Sputtering, Cathodic. See CATHODIC SPUTTERING.

Square Law Condenser. A form of variable air condenser, used for wave meters and for tuning wireless circuits generally, in which the plates are so shaped that angular displacement is proportional to the square of the capacitance so that a straight line scale of wave-length is obtained. Cf. STRAIGHT LINE FREQUENCY CONDENSER.

Squegger Oscillator. A thermionic oscillator constructed to give short successive pulses of oscillations by the action of a grid leak which permits of a grid bias building up during the oscillating periods to a prohibitive value and dying down to a restarting value during the quiescent periods.

Squirrel-Cage Induction Motor. An *Induction Motor* in which the rotor "winding" consists of bars through the slots connected to rings at each end forming a short-circuited winding without any external connection through slip rings. Used for small motors which

can be switched straight on to the full voltage without harmful rush of current, and for larger motors where a reduced voltage can be applied for starting and full torque is not required until full speed is reached, e.g. for driving centrifugal pumps. In an improved form, the rush of current at starting is lessened by the use of iron sheathed rotor conductors which have a higher resistance at the higher rotor frequencies occurring at starting.

Squirrel-Cage Motor, Double. See DOUBLE SQUIRREL-CAGE MOTOR.

Squirrel-Cage Repulsion Motor. A type of single-phase motor with a squirrel-cage winding under a commutator winding on the rotor; running as an induction motor when up to speed, but with a series characteristic when starting.

Squirrel-Cage Rotor. See SQUIRREL-CAGE INDUCTION MOTOR.

Squirled Filament. An incandescent lamp *Filament* prepared by extruding or "squirting" a composition through a die with a fine hole in it, and afterwards applying heat treatment (in an atmosphere free from oxygen) to the thread thus produced; in the case of tungsten filaments, to drive out the binding materials used in making the original paste and to leave a hard filament of pure metal; or, in the case of carbon filaments, to carbonise the thread and to make it homogeneous. The method was in extensive use, with many modifications, before it was found practicable to draw a fine enough wire of tungsten by a true wire-drawing process.

Stabilised Arc Circuit-Breaker. An oil circuit-breaker in which the break takes place within pots of magnetic material which have a controlling effect on the arc.

Stabiliser (in Long Distance Telephony). A device for preventing instability, i.e. avoiding self-oscillation, in a repeater circuit; sometimes consisting of a voice-operated relay producing an increase in amplitude in the direction of speech.

Stabilising Resistance. A resistor

across the receiving end of a telephone repeater circuit preventing impedance variation beyond the limits of stability.

Stability (1. In General). The power of any system, apparatus, etc., to maintain certain characteristics constant during varying conditions. (2. of a Generator). The property of maintaining its field notwithstanding variations of load, excitation, etc. If a shunt wound machine is worked on the lower part of its saturation curve, it is apt to become unstable, as slight reduction of the excitation will cause it to lose its field. (3. Of a Power System) the property of being able to avoid the falling out of step of some of the generators running in parallel on that system when abnormal conditions due to overloads, surges, etc., are produced. See MAGNETIC INSTABILITY.

Stability, Magnetic. See MAGNETIC STABILITY.

Stability Ratio. A term applied to automatic circuit-breakers to indicate the ratio of the maximum current that can safely be broken to the minimum fault current setting.

Stabilivolt. An apparatus consisting of a gas-filled tube, with a number of concentric coated iron electrodes, ionised by a d.c. voltage between the extreme inner and outer ones. The voltage between the intermediate electrodes is found to remain remarkably constant in spite of a considerable range of variation of the terminal voltage, so that the apparatus can be used as a source of practically constant e.m.f. with apparatus consuming very small currents.

Stage Lighting. The electrical illumination of a theatre stage, partly by means of general lighting from rows of white and coloured incandescent lamps in suitable reflectors in vertical and horizontal positions above, and the sides and in front (see BATTENS, PROSCENIUM LIGHTS, FLOAT, etc.), and partly by local lighting from *Projectors* and movable groups of lamps (see BUNCH LIGHTS, FLOOD LIGHTS, etc.), and

sometimes with the addition of *Decorative Lamps* of comparatively small size about the stage.

Stage Pockets. *Sockets* in the stage itself to which connection may be made by plugs and flexible leads where required.

Stage Switchboard. A switchboard, usually situated at the side and in full view of the stage of a theatre, from which the whole of the stage lighting is controlled (and sometimes the auditorium lighting as well), provided with rows of switches and dimmers by which the different coloured lamps in every section of the *Float, Battens, Hanging Lengths*, etc., can be controlled separately or collectively, and the dimmers in all the circuits worked separately or coupled together in groups, or all worked together.

Staggered Brushes. Brushes in which the different groups are purposely set out of line with one another to avoid wearing the commutator into grooves.

Staggered Poles. Pole pieces of a certain type of inductor alternator with all the north poles to one side, and the south poles on the other displaced relatively to each other, so that each north pole is opposite the interval between two south poles.

Stalloy. A special steel containing about 2.75 per cent of silicon and also manganese, sulphur and phosphorus, suitable for transformer cores, etc., on account of its low hysteresis loss, and low eddy current loss, due to its high Specific Resistance. It is also used for telephone receiver diaphragms.

Stamped Poles. Pole pieces built up of laminations.

Stampings. See LAMINATIONS.

Stampings: Armature and Transformer. See ARMATURE STAMPINGS and TRANSFORMER STAMPINGS.

Stand, Insulating. See INSULATING STAND.

Stand-By Switch. A switch sometimes provided in wireless receiving apparatus for changing over from connections giving sharp tuning to those for flat tuning while searching.

Standard : Board of Trade, Matthiessen, Platinum, Portable, Primary, Reference, Table, Violle, and Working. See BOARD OF TRADE STANDARDS, MATTHIESSEN STANDARD, etc.

Standard Cable. A cable of particular size and variety used as a standard in comparing the transmission constants of telephone cables and circuits, which are thus spoken of as being equivalent per mile to so many miles of standard cable. This standard cable which, under ordinary circumstances is good for telephone transmission up to about 50 miles, has a conductor weighing 20 lb. per mile, a loop resistance of 88 ohms per mile, a capacity of 0.054 mf. per mile, an inductance of 0.001 henry per mile, and a leakage of 1 microhm per mile, and an *Attenuation Constant* of 0.103.

Standard Cable Equivalent (S.C.E.). The number of miles of *Standard Cable* which a circuit, or part thereof, is equivalent to, or the number of additional miles to which the losses due to any particular cause are equivalent, or the reduction in miles of standard cable to which the *gain*, due to a repeater or other device, is equivalent.

Standard Candle. See INTERNATIONAL CANDLE.

Standard Capacitor or Condenser. A capacitor carefully made so that its capacity is not likely to vary, and adjusted accurately to a value such as half a microfarad; usually provided with arrangements whereby it can be kept short-circuited to avoid possibility of effect of *Residual Charges*.

Standard Cell. A *Primary Cell* which, when made according to a given specification, can be relied upon to give with considerable accuracy a known E.M.F. under known conditions of temperature; used for the adjustment of potentiometers, etc.

Standard Cell : Cadmium, Clark, de la Rue, and Weston. See CADMIUM CELL, CLARK CELL, etc.

Standard Frame. One of a series of carcasses kept in stock by dynamo builders ready to be provided with

windings to suit individual requirements.

Standard Lamp. (1) A portable or other lamp which stands upon the floor, table, etc. (2) A standard source of illumination for photometry, either a specially calibrated incandescent lamp kept for the purpose of a working substandard, or a primary standard such as a *Pentane, Hefner, or Carcel Lamp*.

Standard Miles. An expression used in stating the improvement in the quality of a telephone circuit obtained by some alteration, e.g. the adoption of *Loading* or *Repeaters*, meaning that the effect is equivalent to the ability to speak clearly over so many additional miles of *Standard Cable*, the attenuation of which is 800 cycles in 0.1065 neper per mile.

Standard Noise Generator. See NOISE MEASUREMENT.

Standard Ohm. The actual value of a resistance standard such as the *International Ohm*, or a *Standard Resistance*, made to have a value as nearly as possible equal to it, for use in resistance comparisons.

Standard Resistance. A resistance carefully made so that its value is not likely to alter (except in a known manner with temperature), and adjusted to a known value for use in laboratory measurements.

Standard Sporm Candle. An obsolete light standard consisting of a sporm candle, weighing $\frac{1}{2}$ lb., consuming 120 grains per hour.

Standard Waves. See STATIONARY WAVES.

Standard Wire Gauge. See BRITISH STANDARD WIRE GAUGE.

Standing Waves. See STATIONARY WAVES.

Star Connection. The method of connecting up polyphase circuits and apparatus in which one end of each phase is connected to a common or neutral point, which may be earthed, insulated, or connected to a wire to which all the other neutral points on the system are connected. In the case of a three-phase star-connected system, the current in each phase winding, etc., is equal to that in the corresponding branch of the circuit, and the

voltage between the neutral point is equal to $1/\sqrt{3}$ (0.58) of that between phases. Cf. **MESH CONNECTION**.

Star-Delta Control. The method of raising the impedance of a three-phase induction motor for starting, by connecting the stator winding temporarily in *Star* instead of in *Mesh* (or *Delta*), to obtain the equivalent of a reduced voltage.

Star-Delta Switching Starter or Switch. A starter for three-phase induction motors which connects the phases of the stator winding first in star and then in mesh, or "delta."

Star Point. The neutral point of a star-connected system or apparatus to which the one end of each phase is connected.

Star Quad Cable. See **QUAD CABLE**.

Star Voltage. See **VOLTAGE TO NEUTRAL**.

Starter. (1) See **MOTOR STARTER**.
(2) A *Starting Motor* for a petrol or other engine. See also **STANTOR**.

Starter: *Auto-, Automatic, Auto-transformer, Breaker, Cascade, Compensator, Contactor, Drum, Enclosed, Face Plate, Inching, Lever Type, Liquid, Multiple Switch, Open, Rheostatic, Rotor, Self, Semi-Enclosed, Series-Parallel, Slow Motion, Solenoid, Star-Delta, Switch, and Three-Phase.* See **AUTO-STARTER**, **AUTOMATIC STARTER**, etc.

Starting Box. A term sometimes applied to the smaller sizes of motor starters.

Starting Current. The value of the current taken by a motor during starting. Cf. **RUNNING CURRENT**.

Starting Motor. An auxiliary motor used for starting such apparatus as *Rotary Converters* and *Synchronous Motors*. See also **SELF-STARTER**.

Starting Position. The position of the handle of a controller, starter, starting switch, etc., which makes the connections for starting. Cf. **RUNNING POSITION**.

Starting Resistance or Resistor. A resistor for insertion temporarily into a motor circuit for starting.

Starting Resistor, Automatic. See **AUTOMATIC STARTING RESISTOR**.

Starting Rheostat. A starting resistance which can be varied in value,

e.g. the multiple contact switch and set of resistances connected thereto forming the essential part of the ordinary continuous current lever type starter, or three interlinked variable resistances for the rotor circuit of an induction motor.

Starting Switch. A switch for connecting a motor to the circuit for starting, either directly, or with separate starting and running positions, for different arrangements of connections. A more complicated arrangement in which resistances, etc., are involved is usually called a *Starter*.

Starting Torque. The torque given by a motor during starting conditions.

Starting Transformer. A transformer used to obtain a reduced voltage for starting an alternating current motor.

Starting Winding. Any auxiliary winding in a motor used only at starting.

Stator. A spelling of *Starter*, proposed on the ground that the termination -er should be limited to a person performing an operation while the termination -or should characterise a piece of apparatus.

Start-Stop Printer. A type-printing telegraph receiver which starts operating as soon as a key in the transmitting instrument is pressed, and stops as soon as a letter has been printed.

Stassano Furnace. An indirect arc furnace fed with three-phase current and with three carbon electrodes forming a star connection at the arc. The whole furnace is in the form of a revolving vessel, with the arc above the charge, through which the current does not pass.

Static. (1) A term originally meaning *Electrostatic* in the sense of relating to accumulated charges of electricity at high potential, as opposed to currents, which has come, in practice, to be used in connection with the effects of sudden high potentials due to momentary causes, such as *Surges* in large systems following a sudden redistribution of potential, the concentration of potential at the ends of

transformer windings, etc. (2) Disturbing waves in wireless telegraphy or *Atmospherics* are also sometimes (particularly in America) spoken of as "Statics." (3) The term is also used to distinguish stationary apparatus from moving apparatus, e.g. *Static Transformer*.

Static, End Gap. See **END GAP STATIC**.

Static Balancer. See **ALTERNATING CURRENT BALANCER**.

Static Characteristics (of a Thermionic Valve). Characteristic curves taken under non-oscillatory conditions. See **ANODE-CURRENT CHARACTERISTIC** and **GRID CURRENT CHARACTERISTIC**.

Static Breeze or Static Brush. Names sometimes given to a brush, point, or similar discharge from a high tension conductor when used for curative purposes. See **WIND, ELECTRIC**.

Static Charge. An electrostatic charge, i.e. a quantity of electricity in a conductor at a potential considerably above that of the earth. Used in practice more particularly of charges produced by extraneous causes such as friction of paper passing through rotary printing machines liable to produce sparks or disturbing effects due to electrostatic attraction; or by differences of potential due to atmospheric electricity.

Static Condenser. An ordinary *Condenser* consisting of extensive conducting surfaces separated by a thin dielectric. Cf. **ROTARY CONDENSER**.

Static Component. See **ELECTRO-STATIC COMPONENT**.

Static End Ring (in a Transformer). A metal ring adjacent to the end turns of a transformer for the improvement of voltage distribution, with interruptions preventing it acting as a closed secondary.

Static Frequency-Changer. Any form of frequency changer not containing moving parts, such as those sometimes used in Wireless Telegraphy for obtaining multiples of the original fundamental frequency by reinforcement of harmonics by resonance. Also called *Doublers* and *Triplers* in the cases of twice

and three times the original frequency, or, in general, *Frequency Multipliers*. See also **MERCURY VAPOUR FREQUENCY CHANGER**.

Static Generator. See **ELECTROSTATIC GENERATOR**.

Static Harmonic Absorber. A Harmonic Absorber consisting of a transformer connected to capacitors so as to form a three-phase resonating circuit to absorb one particular harmonic such as the fifth. Cf. **ROTARY HARMONIC ABSORBER**.

Static Hysteresis. Hysteresis produced in the ordinary way in an alternating field distinguished from *Rotary Hysteresis*.

Static Induced Current. A term used in electromedical practice for the charge or discharge current rush in condensers.

Static Leak. A high resistance shunt to a condenser.

Static Machine. See **ELECTROSTATIC MACHINE**.

Static Shock. An electric shock produced by electrostatic apparatus, e.g. by the discharge of a *Leyden Jar*.

Static Transformer. An ordinary alternating current transformer distinguished from converting apparatus with moving parts. Preferably called **STATIONARY TRANSFORMER**.

Static Wave Current. A term used in electromedical practice for the sudden discharge of an insulated patient who had been raised to a high potential by an electrostatic generator.

Static Electricity. Electricity manifesting itself in charges at high potential, e.g. that produced by frictional or influence machines, formerly thought to be distinct from *Galvanic* or *Voltic Electricity*, which manifests itself as a current.

Station : Broadcasting, Central, Converting, Destructor, Generating, Geothermic, Hydro-electric, Intermediate, Power, Receiving, Repeating, Sub-, Supply, Switching, Thermal, Transforming, Transmitting, Water-Power, and Wireless. See **BROADCASTING STATION**, **CENTRAL STATION**, etc.

Stationary Armature. The fixed

armature of a machine such as a revolving field alternator.

Stationary Transformer. See **STATIC TRANSFORMER**.

Stationary Waves. The wavelike distribution of potential along a conductor of finite length when electric waves are propagated from one end along the wire and reflected from the other end, forming stationary nodes and loops analogous to those of a vibrating string. See **LEONER WIRES**.

Stator. The part of a dynamo-electric machine which carries a winding and a core and does not revolve. Cf. **ROTOR**. Used more particularly of alternating current machinery. In the case of *Induction Motors*, usually that part which carries the winding connected to the outside circuit, and in modern types of alternator the *Stationary Armature*.

Stator Core. The whole mass of laminations clamped together in the stator frame of such a machine as a revolving field alternator, or an induction motor, which form the magnetic circuit of the stator and carry its windings.

Stator Frame. The frame, usually of cast iron, supporting the core and winding of the stator of an alternator, motor, etc., particularly of large machines. See references under **FRAME**.

Stays. Wire or other ropes to support a line pole or mast, and take the side pull of the line at bonds and corners, wind pressure, etc.

Steady Brace. See **SIDE ANCHOR**.

Steady Current. A current remaining constant in value for a considerable time.

Steam Balancer. See **DIRECT CURRENT BALANCER**.

Steam-Electric Generating Set. A set in which the generator is driven by a steam engine or turbine. Cf. **HYDRO-ELECTRIC GENERATING SET**, **PETROL-ELECTRIC SET**, etc.

Stearite. A mineral, akin to talc, also known as soapstone, composed chiefly of a silicate of magnesium, sometimes used as an insulator where heat resisting property is an advantage.

Steel (Electric). Steel manufactured in an *Electric Furnace*.

Steel: Non-Ageing, and Non-Magnetic. See **NON-AGEING STEEL** and **NON-MAGNETIC STEEL**.

Steel Armouring. An external protective covering of a cable, of steel wire, ribbon, etc.

Steel Conduit. Steel tube for *Interior Conduit Wiring*.

Steel Facing. The electroplating of an etched copper plate with a thin coating of iron to give greater durability when many copies are to be printed therefrom.

Steel Towers. Framed steel structures to take the place of poles for the support of transmission lines, wireless aërials, etc.

Steering Gear (Electric). Ship's steering gear in which the rudder is moved by an electric motor controlled through the action of the ordinary steering wheel; either arranged so that the motor is started by the movement of the wheel, and stopped automatically when the rudder has reached an angle corresponding to the position to which the wheel has been moved, or, in which the motor is always running and is connected to the rudder by a hydraulic or other variable speed gear controlled by the wheel.

Steinmetz Coefficient. The factor by which the 1.6th power of the flux density (B) must be multiplied to give the approximate hysteresis loss in ergs per c.c. per cycle, when a particular kind of iron or steel is subjected to cycles of magnetisation with that value of the flux density as a maximum. Also called **HYSTERETIC CONSTANT** and **HYSTERESIS COEFFICIENT**.

Steinmetz Connection. A method of connecting transformers for three-to-two-phase transformation similar to the *Scott Connection*, but with the secondaries "T" connected.

Steljes Printing Telegraph System. A system employing the **A.B.C.** (Wheatstone) transmitter in conjunction with a receiver in which a type wheel, instead of an indicating pointer, is stopped at a point corresponding to a particular letter after the appropriate number of

current impulses have been sent over the line, and then impressed upon a paper strip by the action of a second electromagnet.

Stenode Circuit. A form of super-heterodyne wireless receiving circuit of great selectivity in which a piezo-electric oscillator is employed to limit the intermediate frequency band. A special correcting circuit is employed to avoid distortion.

Step-by-Step Automatic Telephone System. An *Automatic Telephone System*, such as the Strowger system, in which the basic principle is the feeding forward of the selectors one step at a time by a succession of current impulses, as distinguished from *Rotary Systems*.

Step-by-Step Method (of Magnetic Testing). A modification of the *Ballistic Method*, in which a key is used to cut resistances in and out to alter the magnetising force suddenly from one known value to another, when the swing of the galvanometer is an indication of the change of induction. By this means the material can be carried round a closed cycle of magnetisation in steps, and a complete hysteresis loop plotted. The method is liable to produce cumulative errors, and a better way is to start the change in each case from the opposite maximum point in the cycle, using a variable resistance in conjunction with a reversing key.

Step-by-Step Motor. A motor used for signal repeaters, etc., in which the rotor is made to occupy successive angular positions by excitation of different stator poles according to the movement of the sending apparatus.

Step-Down Transformer. A transformer in which the *Secondary Voltage* is lower than the *Primary Voltage*.

Step Switch. See *MULTIPLE CONTACT SWITCH*.

Step-Up Transformer. A transformer in which the *Secondary Voltage* is higher than the *Primary Voltage*.

Step Winding. The arrangement of the rotor of an induction motor with a fairly high resistance wind-

ing for starting, as well as a squirrel-cage winding for running with a sliding ring at one end actuated by a knob at the end of the shaft which can short circuit or disconnect the bars.

Stereophonic Reception. A system of wireless reception producing a sense of direction in components of received sound by the employment of two receivers having a phase difference in the sound emitted. Analogous to stereoscopic vision.

Stethoscope (Electric). A stethoscope for medical use in which the sounds are magnified by means of a microphone, with or without amplification, and heard in a telephone receiver away from the apparatus. In one variety the microphone "contacts" are of osmium-iridium separated by a minute air gap containing ionised air.

Stilb. A unit of brightness equal to 1 c.p. per sq. mm. Cf. LAMBERT.

Stille-Blattnerphone System. See BLATTNERPHONE.

Stobie Furnace. A two-phase arc furnace employing four electrodes, either all four vertical carbon electrodes above the charge, or with two carbon electrodes and two electrodes embedded in the lining.

Stoneware Conduit. Conduit made of earthenware, etc., for the reception of underground cables.

Stop End (of a Cable). An end of a cable with all the conductors insulated and protected.

Stopper Circuit. See REJECTOR CIRCUIT.

Storage Battery and Storage Cell. See ACCUMULATOR.

Storm : Electric and Magnetic. See THUNDER STORM and MAGNETIC STORM.

Straight Current Transformer. See BAR-TYPE CURRENT TRANSFORMER.

Straight Line Capacitance Condenser. A variable condenser with the plates so shaped that the readings of the uniformly graduated dial are proportional to the capacitance. (Also called *Plain Condenser*.)

Straight Line Frequency Condenser. A variable condenser with plates so shaped that the readings of the

uniformly graduated dial are proportional to the frequency of the oscillations to which it is tuned to respond.

Straight Line Wave-Length Condenser. See SQUARE LAW CONDENSER.

Straight Through Current Transformer. See BAR-TYPE CURRENT TRANSFORMER.

Straight Through Joint. An ordinary *Cable Joint*, where no branch is taken from the conductor. Cf. TEE JOINT.

Straight Up and Down Filament. A metal filament mounted in cage form in long zig-zags between two supporting spiders, as in the ordinary form of vacuum tungsten lamp (giving a *Spherical Reduction Factor* of 0.77 to 0.78).

Straightforward Junction (Telephone) System. A system in which a junction line operator is automatically connected to the subscriber's operator at the called exchange.

Strain, Dielectric. See DIELECTRIC STRAIN.

Strain Gauge, Magnetic. See MAGNETIC STRAIN GAUGE.

Strain Insulator. An insulator designed to transmit mechanical tension.

Strand. One of the constituent wires of a *Stranded Cable*.

Stranded Cable. A cable the core of which is composed of a stranded conductor. In cases where great strength is required, the conductive material (copper or aluminium) is laid up in strands round a steel core, and in other cases a flexible cable is made of copper strands round a hemp core.

Stranded Conductor. A conductor made up of several strands laid up in definite layers. Cf. BUNDLED CONDUCTORS.

Strap Coils. Coils of flat copper strip.

Stray Capacitance. Capacitance which exists incidentally between portions of a wireless circuit at different potentials as opposed to capacitance intentionally placed in the circuit.

Stray Currents. Currents returning through the earth in tramway systems, etc., where the return current is taken through uninsulated rails, unless special precautions are

taken to limit the voltage drop in the rails by careful bonding, by reinforcement with *Negative Feeders*, or by *Negative Boosters*. Such currents are liable to cause damage by electrolysis to neighbouring water pipes and other buried metal work, and interference in telegraph circuits which they can enter at one earth plate and leave by another.

Stray Field. The magnetic field produced by *Leakage* lines of force in or near a machine; sufficiently strong in the older types of two-pole machines to upset the working of a watch by magnetising the balance spring. See NON-MAGNETIC WATER.

Stray Load Losses. The balance of the load losses in a machine, etc., not included in the various separately measurable losses.

Strays. See ATMOSPHERICS.

Stream, Arc and Convection. See ARC STREAM AND CONVECTION STREAM.

Streamers. The indefinite wavy luminous bands into which ordinary spark discharges widen out when the gas pressure is reduced to an extent insufficient to produce a glow discharge filling the tube.

Streams, Convection. See CONVECTION STREAMS.

Strength (Electric). See DIELECTRIC STRENGTH.

Strength: Dielectric, Disruptive, and Puncture. See DIELECTRIC STRENGTH, DISRUPTIVE STRENGTH, etc.

Strength of Field. See FIELD STRENGTH.

Strength of Pole. See POLE STRENGTH.

Stress: Dielectric, or Electrostatic. See DIELECTRIC STRESS.

Stretch Effect. The tendency for an elastic or fluid conductor carrying a current to elongate, owing to the force between parallel portions by which it tends to narrow itself. See PINCH EFFECT.

Striae, or Striations. Patches of alternate glow and darkness into which the main body of luminosity or *Positive Column*, in a moderately exhausted vacuum tube, breaks up when the exhaustion is continued beyond a certain limit (about 1/500

atmosphere); separated by *Faraday's Dark Space* from the glow surrounding the cathode; travelling nearer to the anode, and finally disappearing altogether as the exhaustion is carried to a further degree (to about 1/5000 atmosphere).

Striking (in Electroplating). A preliminary deposit at a high current density to be followed by a slower deposit to obtain good surface quality.

Striking an Arc. The starting of an arc by separating the points of the carbons after the current has commenced to pass, or bringing them together and separating them to re-start the arc if it has been extinguished through the carbons having been drawn too far apart, or through any other cause; performed automatically in most arc lamps and by hand in some cases, as in the simpler projector lamps.

Striking Distance. A term sometimes used for *Sparking Distance*.

String Electrometer. See FILAMENT ELECTROMETER.

String Galvanometer. See EINTHOVEN GALVANOMETER.

Strip: Bow and Collector. See BOW STRIP and COLLECTOR STRIP.

Strip Frequency. See LINE FREQUENCY.

Strip Lighting. Lighting by rows of lamps, usually of tubular form, arranged in line in special reflectors.

Strip-Wound Armature. An armature in which the winding is composed of strip copper.

Stroboddyne Reception. A system of reception in wireless telephony similar to *Superheterodyne Reception*, in which the intermediate frequency is obtained by a somewhat different form of interaction between the frequencies of the auxiliary oscillator and the received waves, on an interference principle analogous to *Stroboscopic Methods*.

Stroboglow. A form of *Neon-electric Stroboscope* employing a thermionic oscillator to effect the intermittent illumination of the lamp.

Stroboscope, Neon-Electric, and Thyatron. See NEON-ELECTRIC

STROBOSCOPE and THYRATRON STROBOSCOPE.

Stroboscopic Direction Finder. A *Wireless Direction Finder* with a rotating frame aerial system connected through amplifiers to a pair of neon tubes or a disc rotating at the same speed which light up momentarily, the position corresponding to the bearing of the received signal.

Stroboscopic Method. A method of measurement of speed, frequency, slip, etc., depending upon the observation of a moving object at regular intervals only; e.g. by viewing it by the light of a series of sparks of known frequency, or by the light of an alternating current lamp, or through regularly placed slits in a revolving disc.

Strobostron. A caesium activated cathode gas discharge tube particularly adopted for stroboscopic purposes.

Strowger Automatic Telephone System.

A system of automatic telephone exchange working characterised by the use of successive step-by-step *Selector* switches, actuated by current impulses produced by the rotation of a dial on the subscriber's instrument. The selector switches are entirely electromagnet and contain a number of tiers of fixed contacts, each row arranged in a semicircle, and a moving contact arm which first rises to the height of the tier required, and then swings round and stops over the required contact.

Stubs' Wire Gauge. An obsolete wire gauge in which the diameters of the wires for each designation were larger than in most of the other gauges.

Stud. The contact knob or plate, level with or slightly projecting above the road surface, used to convey the current to the cars in a *Surface Contact System* of traction.

Stud, Brush. See BRUSH-ARM.

Stud Current Transformer. See BAR-TYPE CURRENT TRANSFORMER.

Subaudio-Frequency Telegraph System. A system in which telegraphic signal currents at a frequency below audibility are superposed on an ordinary telephone

circuit and selected by suitable filter circuits.

Sub-Centre. A point in the arrangement of distributing mains or interior wiring where one or more sub-circuits leave the main circuit. See SUB-CIRCUIT.

Sub-Circuit. A branch of a main circuit. In interior wiring, a circuit protected by its own fuses from a distribution board.

Sub-Control System. The last low frequency amplifier before the modulating system in a wireless transmitting station.

Subharmonics. Oscillations or alternating currents of a frequency which is a sub-multiple of the fundamental frequency. Cf. HARMONICS.

Submains. Subsidiary circuits in interior wiring from a main distribution board, from which further branch circuits are taken from branch distribution boards.

Submarine. A ship, usually for war purposes, travelling at times under water. Usually propelled when on the surface by oil engines or steam engines, but under water, entirely by electric motors taking current from large accumulator batteries. These batteries are charged by the same motors acting as dynamos on the surface, driven by the main oil or steam engines.

Submarine Bell. A bell suspended under water and usually electrically actuated; used for transmitting signals by sound waves passing through the water and picked up by a microphone arrangement on board ship or at harbours, etc. Intended particularly for signalling in times of fog. See also SUBMARINE SIGNAL.

Submarine Cable. A cable laid under water on the bed of the sea, river, lake, etc., for telegraph, telephone, or power purposes. Usually, in the case of telegraph and telephone cables, insulated with gutta-percha, and in some cases carrying steel armouring. See ATLANTIC, DEEP SEA, INTERMEDIATE, and SHORE-END CABLES. Submarine telephone cables in many cases are provided with *Loading Coils* or *Distributed Inductance*. Submarine power

cables are only used for comparatively short distances.

Submarine Call Bell. A bell actuated through delicate relays by the small current in a submarine telegraph cable to call the attention of the operator.

Submarine Relay. A telegraph *Relay* of great sensitiveness, for use on submarine cable circuits. See BROWN RELAY, GULSTAD RELAY, etc.

Submarine Signal. An improved form of the original *Submarine Bell* in which the transmitter is a large tuned diaphragm vibrated by alternating current.

Submarine Telegraphy. Telegraphy through *Submarine Cables*; differing from land telegraphy mainly in the long distances dealt with and in the lower speed of signalling possible on account of the effect of the capacitance of the cable, which hinders both the growth and extinction of each current impulse.

Submarine Telephony. See SUBMARINE CABLE.

Submerged Aerial. An *Aerial* submerged in water.

Submersible Motor. A motor for driving apparatus such as centrifugal pumps, which has to work immersed under water; usually of the squirrel cage type with waterproof insulation to the stator windings, but without a watertight enclosing case. Cf. WATERTIGHT MOTOR.

Submodulator. An amplifying valve used between the microphone circuit and the modulating valve in a wireless transmitting equipment.

Subpermanent Magnetism. That part of the magnetism which remains in a "permanent" magnet for some time after magnetisation, but disappears in course of time, leaving only the real *Permanent Magnetism*. The removal of the subpermanent magnetism can be accelerated by mechanical vibration or by moderate heating for a certain period.

Subscriber's Line. A telephone line connecting a subscriber's apparatus with a telephone exchange.

Subscriber's Loop. The part of a telephone circuit, including the *Subscriber's Line* and apparatus.

Subscriber's Multiple. See **MULTIPLE**.
Subscriber's Rotary Line Switch. See **PRESELECTOR**.

Substation. An establishment, usually either in a separate building or forming part of a consumer's premises, where electrical energy, supplied at a high pressure for convenience in transmission, is transformed to a pressure convenient for utilisation or converted from alternating to direct current or to a different frequency, etc.

Substation : Automatic, Fully Automatic, Outdoor, Portable, and Semi-Automatic. See **AUTOMATIC SUBSTATION**, **FULLY AUTOMATIC SUBSTATION**, etc.

Substation Switchboard. A switchboard for the control of the circuits entering and leaving a substation, and the transforming or converting plant therein. Usually there are two independent boards for the high tension and low tension sides kept as far apart as possible.

Substitution Method. A method of measuring resistance by noting the deflection which the current sent through it by any convenient e.m.f. produces in a galvanometer, and then connecting up a resistance box in place of the unknown resistance, and adjusting its value till the same deflection is produced.

Substitutional Resistance. A resistance used to replace one of a number of arc lamps, or other pieces of apparatus, in series, so that the value of the current is not affected by cutting the lamp, etc., out of the circuit. See **SERIES CUT-OUT**.

Succession of Phases. The order in which the maxima of the currents in the different phases of a three-phase or other polyphase circuit occur; determining the direction of rotation of a polyphase induction motor, etc. (Also called *Phase Sequence*.)

Sucking Booster or Transformer. A *Booster* or *Transformer* used in the manner of a *Negative Booster* on a traction system, etc., to compensate for voltage drop.

Sulphating. The formation in lead accumulator cells of a white,

insoluble deposit of lead sulphate on the plates, which is liable to be produced if the cells are left uncharged for any time after being freshly filled with acid, or are left without charging after being over-discharged. Such action destroys the capability of the plates to retain a charge.

Summation Transformer. A current transformer with a secondary to be connected in parallel with the secondaries of similar transformers to enable the sum of the currents in several circuits to be indicated or integrated.

Summator. An instrument for adding together the indications of the meters on several circuits actuated by impulses sent for each revolution of the spindles of the meters by a special contact maker or *Summatory Attachment*.

Summatory Attachment. See **SUMMATOR**.

Summatory Meter. A meter fitted with a *Summatory Attachment*.

Sumpner's Method (of *Transformer Testing*). A method of testing two similar transformers and determining their losses under full load conditions without corresponding expenditure of power analogous to the *Hopkinson Test* of dynamos.

Sunk Switch. See *Flush Switch*.

Sunlight Lamp. A lamp giving light rich in ultra-violet rays, in which a short mercury vapour arc between tungsten electrodes is run in parallel with a tungsten filament in a small exhausted bulb containing a pool of mercury vapourised by the heat of the filament.

Super-Audio Frequency. A frequency higher than that of audible sound.

Super-Audio Frequency Modulated Waves. Continuous waves modulated at a frequency above that of audible sound, as used in television, etc.

Super-Audio Telegraph Systems. Systems employing current at super-audio frequencies superposed on circuits carrying other traffic to provide additional telegraph channels. Frequencies up to more than 4000 cycles are employed for this purpose.

Supercharge (Electric). A term used

in marine engineering for an electric motor on the propeller shaft of a ship driven by reciprocating engines, supplied by a turbo-alternator running off exhaust steam from the main engines. Better efficiency is obtained in this way than if the main engines exhaust directly into a condenser.

Super-Conductivity. The state of very high conductivity, amounting almost to zero resistance, found in some metals, alloys and metallic compounds within a few degrees of the absolute zero of temperature.

Superconductor. A material which, when cooled almost to absolute zero, passes into a state of super-conductivity.

Super-Excited Condenser. A synchronous condenser arranged so that the excitation can be suddenly increased considerably in order to increase its output under short-circuit conditions.

Superhet. Popular term for a *Superheterodyne Receiving Set*.

Superheterodyne Reception. A system of wireless reception in which local oscillations (or a harmonic thereof) of slightly different frequency from the received oscillations, obtained from an auxiliary valve or from the main rectifying valve, are superposed upon the received oscillation so as to produce beats of a frequency intermediate between radio and audio-frequencies at which amplification can be conveniently carried out. This system is suited for long distance reception, with a number of amplifying stages, and can be made of great selectivity. Cf. STROBODYNE and ULTRADYNE RECEPTION, and see also HYPERDYNE RECEPTION and STENODE CIRCUIT.

Super-Phantom Circuit. A telegraph circuit with two separate loops for sending and receiving respectively, each superposed on a telephone *Phantom Circuit*.

Superposed (or Superimposed) Circuit. A circuit for telegraph or telephone purposes, formed by superposing currents upon a circuit, or parts of more than one circuit, being used at the same time for other messages. See RETARDATION

METHOD, EQUIPOTENTIAL METHOD, PHANTOM CIRCUIT, CARRIER-CURRENT TELEGRAPHY, etc.

Superposed (or Superimposed) Current.

A current, of different nature to that already existing in a circuit, added in the whole or part of that circuit and producing a resultant current, the components of which can be recognised by suitable apparatus, e.g. a telegraph current superposed on the current in a telephone circuit or *vice versa* (See references under SUPERPOSED CIRCUIT), or a high frequency current for telephony or other signalling, or for actuating auxiliary apparatus superposed on the main current in a power line.

Superposed Ringing Current. An expression usually limited to a direct ringing current superposed upon an alternating ringing current enabling either or both of two bells on the same circuit to ring at will.

Super-Power Valve. A *Power Valve* of large size, capable of dealing with grid sweeps of 30-40 volts, and in its later forms with a *Screened Grid* giving an amplification factor up to 100. See also PENTODE.

Super-Retroaction. See SUPER-RETROACTIVE RECEPTION.

Super-Retroactive Reception. A system of wireless reception in which *Retroaction* is applied to an extent that can produce strong self-oscillation, while an auxiliary oscillator of a much lower frequency is employed to check these oscillations periodically, after which they build up again to an extent proportional to the strength of the received oscillations, so that the resulting effect, duly amplified, will represent the received signal. This arrangement is also called *Super-Retroaction*.

Supersonic Amplification. See SUPER-HETERODYNE RECEPTION.

Supersonic Frequency. A frequency higher than that of sound waves within the limits of audition. Cf. AUDIO-FREQUENCY.

Supersonic Heterodyne Reception and Supersonic Reception. See SUPER-HETERODYNE RECEPTION.

Supersonic Sounding. A method of

Echo Depth Sounding employing sound waves above the limits of audition, detected by quartz resonators.

Supertension Cable. A cable for power transmission or distribution at voltages of 20,000 volts and over, sometimes of the single core type.

Supertonic Frequency. See SUPER-SONIC FREQUENCY.

Supertonic Heterodyne Reception. See SUPERHETERODYNE RECEPTION.

Supervisory Control. See SEMI-AUTOMATIC SUBSTATION.

Supervisory Lamp. A signal lamp on a telephone exchange switchboard controlled by relays in the operator's *Cord Circuit*, which lights up when the operator inserts a calling plug into the jack of the wanted line, and remains alight until the called subscriber takes his instrument off its hook, remaining extinguished until he hangs it up again. When the supervisory lamp and the calling subscriber's *Line Lamp* have both lighted up again the connection can be cleared.

Supervisory Relay. A relay which controls a *Supervisory Lamp* on a telephone exchange switchboard.

Supervisory Signals. Signals given by *Supervisory Lamps*, etc., indicating whether a line is in use or not.

Supplementary Anode. A small extra anode used locally in electro-deposition to improve the uniformity of the deposit.

Supply (Electric). The supply from a public generating station of electrical energy on a large scale to consumers.

Supply, Bulk. See BULK SUPPLY.

Supply Main. The wires, cables, etc., belonging to a supply authority, extending into a consumer's premises as far as the terminals protected by double pole fuses, where his own installation commences; thus including both the outside *Distributing Mains* and the *Service Cables*, etc.

Supply Meter. An integrating meter on a consumer's premises for determining the amount of energy consumed.

Supply Station. A *Generating Station*

for giving a public supply of electrical energy.

Suppressed Automatic Volume Control. See DELAYED AUTOMATIC VOLUME CONTROL.

Suppressed Carrier Wave Telephony. A system of carrier wave (line or wireless) *Telephony* in which the excess of unmodulated carrier wave is filtered out and not transmitted, but is re-introduced in the receiving apparatus in sufficient quantity to prevent distortion. See also SINGLE SIDE BAND TELEPHONY.

Suppressed Zero Instruments. Indicating instruments intended for use only over the upper part of their total range, in which an open scale is obtained by making the controlling force sufficient to hold the moving system against the zero stop until a prescribed value of the quantity to be measured is attained.

Suppressor Grid. See ANTI-SECONDARY GRID.

Supra-acoustic Telegraph Systems. See SUPER-AUDIO TELEGRAPH SYSTEMS.

Supraconductivity. See SUPERCONDUCTIVITY.

Supradynic Reception. See SUPERHETERODYNE RECEPTION.

Surface : Anode Current, Comparison, Equipotential, Reducing, and Test. See ANODE CURRENT SURFACE, COMPARISON SURFACE, etc.

Surface Brightness. A term usually limited to the *Brightness* of a surface omitting reflected or transmitted light, but not in itself a source of light. Cf. INTRINSIC BRILLIANCY.

Surface Contact System (of Traction).

A system of electric traction for tramways, etc., in which the live conductor is contained in a closed conduit underground, and connection is made to the car by means of studs in the road, which are automatically connected to the underground conductor only when the car is passing over them. See STUD and CONTACT SKATE.

Surface Leakage. Leakage of current across the surface of an insulator through a slightly conducting film of moisture or dirt. *Porcelain Insulators*, etc., are usually made

with a corrugated surface to increase the length of the leakage surface, and for outdoor use are made with *Petticoats* so that a portion of the surface remains dry during rain.

Surface Resistivity. The measure of the resistance to surface leakage offered by an insulator; expressed usually in megohms per centimetre square of the surface.

Surface Switch. A switch for mounting directly on the surface of a wall, board, etc.

Surface Wiring. Interior wiring in which the conductors are not buried in the wall, etc., but are on the surface, enclosed in tube or casing, or supported on cleats or insulators. Cf. **BURIED WIRING**.

Surface Wound Armature. See **SMOOTH CORE ARMATURE**.

Surge. A powerful wave of high potential in a transmission line or other system, due to such causes as direct lightning stroke or charges induced by lightning or sudden rearrangement of potential due to short-circuits or switching large loads on and off, *Oscillations* due to *Resonance*, etc., and capable of causing considerable damage unless properly guarded against.

Surge Absorber. A device used for the protection of apparatus from steep-fronted and high-frequency surges, etc., by providing for the absorption of the energy of the surge. One form consists of a reactance coil surrounded by an oil-cooled metal cylinder in which eddy currents are induced.

Surge Arrestor and Surge Gap. See **ARRESTER**.

Surge Crest Ammeter. An instrument for ascertaining the maximum value of a current surge by measuring the remanent magnetism in a piece of magnetic material in a suitable position relatively to the current.

Surge Dissipator. See **SURGE ARRESTER**.

Surge Generator. An apparatus for producing a momentary high voltage sometimes in the order of a million volts, by such an arrangement as that described under *Impulse Circuit* (2) or by suddenly

placing in series a number of capacitors charged in parallel. See also **MARX CIRCUIT**.

Surge Recorder. An instrument for recording surges such as the *Klydonograph* and certain forms of cathode ray oscillograph. The term is also applied to quick acting graphic instruments provided with relays start or increase the speed of the recording chart or film as soon as a disturbance has commenced.

Surgical Diathermy. See **DIATHERMIC SURGERY**.

Surgical Lamp. A lamp used by surgeons for operations and examinations. See **HEAD LAMP**.

Surinam Eel. See **EEL (Electric)**.

Susceptance. The ratio of the *Intensity of Magnetisation* (J) to the *Magnetising Force* (H) producing it. Positive in *Ferro-magnetic* and *Para-Magnetic* materials, zero for air, etc., and of slight negative value for *Dia-magnetic* materials. Symbol: B or b . Formerly called *Magnetic Susceptibility* while the term *Susceptance* was sometimes used for the component of *Admittance* which gives the wattless component of the current when multiplied by the c.m.f.

Susceptance, Differential. See **DIFFERENTIAL SUSCEPTANCE**.

Susceptibility. See **SUSCEPTANCE**.

Susceptor Phase Advancer. A *Phase Advancer* controlling the magnetising current of the induction motor in conjunction with which it works, by the effect of the component of the voltage generated at right angles to the slip, this being proportional to the secondary voltage, e.g. the *Kapp Vibrator* and the *Leblanc Recuperator*. Cf. **EXPEDOR PHASE ADVANCER**.

Suspended Railway. An electric railway in which the cars are suspended from a single elevated running rail.

Suspenders. Slings of leather, etc., by which overhead cables are suspended from a *Suspension Wire*.

Suspension: Bifilar, Bowstring, Bracket-Arm, Catenary, Catenary Cross Span, Central Bracket, Centre

Pole, Flexible, Nose, Rigid, Semi-Rigid, Side-Bar, Side-Bracket, Side-Pole, Single Cross Span, Span-Wire, Unifilar, Wheelbarrow, and Yoke. See **BIFILAR SUSPENSION, BOW-STRING SUSPENSION**, etc.

Suspension Insulator. An insulator for high tension overhead lines by which the line wire is suspended from a chain of several porcelain or other insulating units connected together by metal links. Such chains of insulators can deal with higher voltages than the single insulator of the pin type, but the voltage gradient is not equally divided among the units, for those at the line end of the chain are subjected to the greater part of the pressure, unless special precautions are taken. They are commonly used for pressures from 70,000 to 220,000 volts. (Sometimes called *Chain Insulators*.)

Suspension Push. See **PENDANT PUSH**.

Suspension Switch. See **PENDANT SWITCH**.

Suspension Wire. A wire of high tensile strength from which an overhead cable is suspended by slings, also called *Messenger Wire*.

Swamping Resistance. A high resistance connected in series with the copper coil of a voltmeter and made of a material of negligible temperature coefficient, so as to "swamp" the effect of the variation with temperature of the copper working coil.

Swan-neck Insulator. A pin-type insulator with a curved pin arranged to bring the point of attachment of the conductor into the same horizontal plane as that of the pin to its support.

Sweating Thimble. A metal piece, with an eye or other conveniently shaped end for making connections; fixed on to the end of the conductor of a cable, etc., by means of solder after the strands have been inserted into the hollow interior.

S.W.G. See **BRITISH STANDARD WIRE GAUGE**.

Swing Oscillations. Oscillations in a *Thermionic Valve* circuit independent of the natural frequency of the

circuit, caused by sudden change of stability conditions.

"S" Wire. The wire in a telephone exchange connected to the *Sleeve* of the plug. (Also called the "*O*" *Wire, Testing Wire, Holding Wire, and Third Wire*.)

Switch. (1) An appliance for opening or closing a circuit or making some alteration of connections at will.

(2) An old-fashioned term for a (telegraph or) *Telephone Switch-board*.

Switch: Accumulator, Aerial, Aerial Earthing, Air-Break, Asylum, Auto, Automatic Transformer, Auxiliary, Battery, Berry Transformer, Break-down, Bus-Bar Sectionalising, Button, By-Pass, Canopy, Ceiling, Change-Over, Control Limit, Coupled, Dead-End, Dial, Detachable Key, Disconnecting, Double-Break, Double-Pole, Double-Throw, Earthed, Electromagnetic, Electropneumatic, Electrosynthetic, Emergency, Equaliser, Expansion, Feeder, Feeler, Feet, Field-Discharge, Field Splitting, Float, Flush, Foot, Fuse, Gang, Gas-Blast, Gate, Gate By-Pass, Gravity, Home Office, Hook, Horn-Break, Hospital, Intercommunication, Intermediate, Interlocking, Isolating, Key, Knife, Laminated Brush, Landing, Lightning, Limit, Linked, Locked Cover, Locking, Main Limit, Mast, Master, Mercury, Microgap, Motor-Operated, Motor-Starting, Multibreak, Multiple Contact, Multipole, Multiway, Oil, Oil-Break, One-Way, Panel, Paralleling, Pendant, Plug, Plunger, Pneumatically Operated, Pole, Pole-Changing, Pressel, Pull, Push-Button, Quick-Break, Quick Make and Break, Range, Recessed, Regulating, Remote Control, Reversing, Rotary, Section, Sectionalising, Selecting, Selector, Semi-Recessed, Sequence, Series-Parallel, Shockproof, Single-Break, Single-Pole, Single-Throw, Single-Way, Short-Break, Slack-Rope, Slow-Break, Slowing, Snap, Solenoid, Stand-By, Step, Sunk, Surface, Tandem Knife, Tappet, Temperature, Three-Point, Three-Pole, Three-Way, Throttle, Throw-Over, Time, Track, Transformer, Trip, Triple-Pole, Tropical, Tumbler,

Tuning, Turn, Two-Pole, Two-Way, Unit, Vacuum and Wax-Operated. See ACCUMULATOR SWITCH, AERIAL SWITCH, etc. See also references under SWITCHGEAR.

Switchboard. Originally a collection of switches, instruments, etc., mounted on a flat board for the control of electrical plant or circuits. The meaning, however, has broadened out to any collection of switchgear, whether arranged upon panels or in any other way.

Switchboard: Accumulator, Branch, Cellular, Cordless, Dead Front, Frame Type, Panel, Skeleton Type, Stage, Substation, Telephone, and Trunk. See ACCUMULATOR SWITCHBOARD, BRANCH SWITCHBOARD, etc. (See also references under SWITCHGEAR.)

Switchboard Cubicle. A chamber separated by fireproof partitions from adjoining chambers, for the reception of high tension switchgear. Usually closed by a door which can only be unlocked when the switchgear within is disconnected from the circuit by isolating links or switches, which can only be closed when the door is shut.

Switchboard Gallery. A gallery in a generating station, etc., from which access is gained to either the operating panels of a switchboard or the cells in which the actual switchgear is contained.

Switchboard Instruments. *Measuring Instruments* such as *Ammeters, Voltmeters*, etc., of a form suitable for mounting on a switchboard.

Switchboard Panel. See PANEL.

Switchboard Meters. A term sometimes applied to all switchboard instruments, but usually limited to *Integrating Meters* of a type suitable for mounting on switchboards.

Switch-Cabin. A cabin alongside an electric railway containing switches, automatic circuit-breakers, etc., controlling the supply of energy from feeders to sections of the contact line.

Switch-Fuse. A term used indiscriminately for a *Fuse Switch*, a fuse fitted with a removable *Fuse Carrier* which can be used as a switch by being plugged into, or withdrawn from, fixed contacts or

any other combined switch and fuse.

Switchgear. All kinds of switches, circuit-breakers, starters, protective apparatus, etc., used in connection with the control of a station, installation or apparatus, whether mounted on a switchboard or not.

Switchgear: Air-Insulated, Carriage Type, Cellular, Compound-Filled, Draw-out, Drip-Proof, Dust Proof, Enclosed-Ventilated, Explosion-Proof, Flame-Proof, Immersible, Internal, Isolation, Ironclad, Isolated-Phase, Metal-Clad, Oil-Immersed, Open, Outdoor-Type, Pillar-Type, Protected, Semi-Enclosed, Separated Phase, Totally Enclosed, Truck-Type, Splash-Proof, Watertight, and Weather-proof. See CARRIAGE TYPE SWITCHGEAR, AIR-INSULATED SWITCHGEAR, etc.

Switchgear Pillar. See SWITCH PILLAR.

Switch-Hook. (1) A hook on which a telephone receiver is hung in a subscriber's set when out of use, arranged to alter the connections when relieved of the weight of the instrument from those for receiving a ring to those for making or answering a call. In the *Central Battery System*, the raising of the hook makes a call signal at the exchange without further action by the subscriber. (2) A hook on the end of a rod for actuating a switch at some distance overhead.

Switching Starter. A starter does not contain any current limiting device, but only serves to make the necessary connections as required.

Switching Station. A separate building containing only switchgear; usually for making connections between alternative feeders or transmission lines, or sometimes containing all the switchgear of a generating station when at a distance from the building containing the generating plant.

Switch-Lampholder. A lampholder containing a switch. (Also called *Key-Holder*.)

Switch-Pillar. A pillar on which switchgear, instruments, etc., are mounted, either forming part of a

"switchboard," or in an isolated position.

Switch-Plate. A cover plate for one or more *Flush Switches*.

Switch-Plug. See **SWITCH-SOCKET**.

Switch-Point. A *Wiring Point* for the fixing of a switch or switches, but not for a lamp connection.

Switch-Room (Telephone). A room in a telephone exchange in which the actual switching operations are carried out either manually or automatically.

Switch-Socket. A switch combined with a plug and socket on one base.

Switch-Springs. A name formerly sometimes used (particularly by Post Office engineers) for telephone *Jacks*.

Switch-Starter. (1) A motor starter made in the form of a single switch, of the knife or similar variety, arranged to close additional sets of contacts by further movement after it has closed the main circuit, and thus to short-circuit successively sections of the starting resistance. (2) A switch providing for different motor connections for starting and running conditions.

Switch-Type Voltage Regulator. An a.c. voltage regulator consisting of a variable ratio transformer in which the number of effective turns is varied by a multiple contact switch. Cf. **MAGNETO** and **INDUCTION VOLTAGE REGULATORS**.

Switchyard. The fenced-in space occupied by switchgear, etc., in stations or substations equipped with outdoor type apparatus.

Swivelling Trolley Head. A trolley head in which the *Harp* is pivoted so that it is adapted to *Side Running*.

Sykes Microphone. See **ROUND-SYKES MAGNETOPHONE**.

Symmer's Theory. The original *Two Fluid Theory* of electricity, regarding *Vitreous* (positive) and *Resinous* (negative) electricity as two different fluids which neutralised each other when present in equal quantities.

Symmetrical Load. A load in a three-phase system which is equal and similar in power factor on all the phases.

Symmetrical Three-Phase System. See **SYMMETRICAL VOLTAGE**.

Symmetrical Voltage. A polyphase voltage system in which the instantaneous sum of the voltages in the various phases is always zero.

Synaut Motor. Proposed abbreviation for *Auto-Synchronous Motor*. Cf. **SYNDUOT MOTOR**.

Synchronise. Two currents, voltages, etc., are said to synchronise when they are of like phase and frequency. The verb is also used for the causing of two currents, etc., to remain in like phase and frequency, and for making connection between two circuits in which this is the case, e.g. connecting an alternator in parallel with others at a moment when its voltage synchronises with that of the others.

Synchronised Induction Motor. See **SYNCHRONOUS INDUCTION MOTOR**.

Synchroniser. (1) See **SYNCHROSCOPE**. (2) In telegraphy, a correcting device for keeping two pieces of apparatus in different stations in step.

Synchroniser : Automatic, Lamp, and Rotary. See **AUTOMATIC SYNCHRONISER**, **LAMP SYNCHRONISER**, etc.

Synchronising. The operation of connecting two circuits carrying alternating voltage after having ascertained that they are correctly in phase.

Synchronising, Pilot. See **PILOT SYNCHRONISING**.

Synchronising Bus-Bars. Auxiliary bus-bars to which an alternator is connected when it is to be synchronised, carrying synchronising gear ready connected thereto, and disconnected from the alternator as soon as it has been switched on to the main bus-bars.

Synchronising Current. The current component circulating in the armature of an alternator not quite in synchronism with the bus-bars, which tends to pull it into synchronism.

Synchronising Gear. All the switch-gear, instruments, etc., necessary to carry out the operation of synchronising a machine.

Synchronising Lamps. Incandescent lamps arranged either in the

secondary of synchronising transformers, or connected across the contacts of the switch, by which an alternator is to be connected to the bus-bars, for the purpose of showing by absence of flicker when synchronism is attained and the switch may be closed.

Synchronising Power. The power due to the *Synchronising Current* which tends to pull a machine into synchronism with the rest of the system.

Synchronising Torque. The torque in an incoming alternator due to the synchronising power which tends to pull it into synchronism.

Synchronising Transformer. See SYNCHRONISER.

Synchronising Voltmeter. A voltmeter connected temporarily across the contacts of one pole of a switch by which an alternator is to be switched into parallel with others, showing by cessation of oscillation of its pointer when the machine is in synchronism. Cf. SYNCHRONISING LAMPS.

Synchronism. The state of affairs when two pieces of apparatus are running in step at equal speed, or currents in two circuits agree in frequency and phase.

Synchronism, Cascade. See CASCADE SYNCHRONISM.

Synchrograph. An early telegraph system modulated by cutting off the top or bottom half waves.

Synchroscope. See SYNCHROSCOPE.

Synchronous Alternator. An alternator usually with a d.c. excitation with a fixed frequency depending upon its speed and number of poles. Cf. ASYNCHRONOUS MACHINE. See SYNCHRONOUS GENERATOR.

Synchronous Capacitor or Synchronous Condenser. An over-excited *Synchronous Motor* used initially or partly for the improvement of the power-factor of a circuit, and thus acting in the same way as a *Capacitor*.

Synchronous Clock. A clock driven by a synchronous motor for use on a.c. systems where the frequency is accurately controlled.

Synchronous Converter. See ROTARY CONVERTER.

Synchronous Generator. See SYNCHRONOUS ALTERNATOR.

Synchronous Impedance. The quantity which determines the ratio of the internal voltage drop in an alternator, etc., to the current, under running conditions; containing components due to resistance and eddy current effects, and reactance due to armature ampere turns, as well as leakage, etc.

Synchronous Induction Motor. An *Induction Motor* which can be converted into a *Synchronous Motor*, after it has been run up to speed, by supplying direct current to the slip rings. Cf. AUTO-SYNCHRONOUS MOTOR.

Synchronous Motor. A motor for alternating current constructed on similar lines to an alternator; usually with a revolving field excited by direct current, and a stationary armature; requiring to be run up to speed by an external agency such as a small auxiliary motor, and synchronised in the same way as an alternator before being put on to the load, but then running at constant (synchronous) speed at any load up to an overload sufficient to pull it out of step. Cf. SYNCHRONOUS INDUCTION MOTOR.

Synchronous Motor: Over-Excited. See OVER-EXCITED SYNCHRONOUS MOTOR.

Synchronous Motor-Generator. A motor-generator in which the motor is of the *Synchronous* type.

Synchronous Reactance. The component of *Synchronous Impedance* due to reactance.

Synchronous Reactor. A synchronous motor with the excitation adjusted to cause retardation of the phase of an alternating current with respect to the voltage. Cf. SYNCHRONOUS CAPACITOR.

Synchronous Rectifier. A rectifier consisting of some form of commutator driven by a synchronous motor.

Synchronous Spark-Gap. A rotary spark gap arranged to give sparks at the same points in successive cycles of the a.c. supply.

Synchronous Speed. The speed of alternating current machinery

corresponding to the frequency of the circuit; equal (in revolutions per minute) to the frequency divided by the number of poles, multiplied by 120.

Synchronous Telegraph Systems.

Telegraph systems depending upon the rotation of contact makers or other apparatus at the same speed and in step at the sending and receiving stations. E.g. MULTIPLEX, HUGHES, and BAUDOT SYSTEMS.

Synchronous Time Motor. A small synchronous motor with or without self starting arrangements for mains driven electric clocks.

Synchroscope. An instrument for indicating whether a machine to be switched on to a circuit is in synchronism with the voltage of that circuit.

Synchroscope Lamp and Rotary. See LAMP SYNCHRONOSCOPE and ROTARY SYNCHRONOSCOPE.

Synduct Motor. Proposed abbreviation for *Synchronous Induction Motor*.

Synterpolator. A form of *Interpolator* containing its own synchronising apparatus.

Synthetic Ammonia Process (for *Fixation of Nitrogen*). The direct combination of atmospheric nitrogen with hydrogen at a suitable temperature in the presence of a catalyst. Some of the various processes used are electrical in so far as they employ electrolytic hydrogen.

Syntonisation. The bringing into *Syntony* of two circuits. See TUNING.

Syntonie Jars Experiment. The famous experiment of Sir Oliver Lodge, in 1889, demonstrating the phenomenon of *Syntony* by adjusting the discharge circuit of a Leyden jar so that it is brought into syntony with another and is caused to spark over across a short spark-gap when the other jar is discharged in its neighbourhood.

Syntony. Two *Oscillating Circuits* are said to be in "syntony" when their natural periods of oscillation are the same, i.e. when one is capable of *Resonating* to the waves produced by the oscillations of the other.

Systoplex. A flexible insulating tube for covering bare wires.

T.]

T. Synbol for *Period*.**Table, Ampere's.** See **AMPERE'S TABLE**.**Table Lamp or Table Standard.** An incandescent lamp in a fitting for standing on a table, connected to a plug and socket by a flexible cord.**Tachometer.** See **SPEED INDICATOR**.**Tachometric Electrometer.** An apparatus for the measurement of very small currents by keeping an electrometer at a fixed reading by compensating for its loss of charge by periodic charges from a small condenser by a contact apparatus driven by a variable speed motor, the speed of which is observed.**"T" Aerial.** An aerial consisting of one or more horizontal wires with the down lead taken from the centre thereof.**Talking Film.** See **SOUND FILM**.**Talking Radio-Beacon.** A radio-beacon the impulses from which are synchronised with audible signals so that distance can be estimated from the time lag between their reception.**Tallygraph and Tallymeter.** Instruments for recording and indicating currents, voltages, etc., at a remote point. Also called *Telemeters*.**Tandem Connection.** See **CASCADE CONNECTION**.**Tandem Knife Switch.** Two or more knife switches coupled together to form a multiple switch with the blades moving in the same plane.**Tandem Selector** (in Automatic Telephony). A selector dealing with incoming junction calls.**Tandem Telephone System.** A method employed in dense areas in which calls are passed through intermediate or "Tandem" exchanges by automatic or manual means.**Tangent Galvanometer.** An early form of galvanometer with a small pivoted needle at the centre of a large circular coil giving a practically uniform field; so called

[Tap

because the current is proportional to the tangent of the deflection. Cf. **SINE GALVANOMETER**.**Tangent Scale.** A scale for instruments in which the quantity to be measured is proportional to the tangent of the deflection, graduated to read directly according to the tangent of the deflection.**Tank, Cable and Transformer.** See **CABLE TANK**.**Tantalum Detector.** A detector of electrical oscillations of the self-restoring coherent type, in which the variable contact is formed by the tip of a very fine tantalum wire just touching the surface of a pool of mercury in a glass bulb.**Tantalum Lamp.** An obsolete incandescent lamp in which the "filament" was formed by a wire of tantalum.**Tap.** See **TAPPING**.**Tap Changer.** A switching apparatus, often of the *Contractor* class, for changing over to different tapplings on a transformer for voltage regulation or on an *Autotransformer* in a.c. railway working.**Tap Changer, On-load.** See **ON-LOAD TAP CHANGER**.**Tap Field Control.** Traction motor control in which the number of effective field turns is altered by means of tapplings on the field windings. Cf. **SHUNTED FIELD CONTROL**.**Tap Field Motor.** A motor with tapplings on the field winding for *Tap Field Control*.**Tap Starting.** Starting of a.c. motors, rotary converters, etc., by the application of reduced voltages from tapplings on the windings of the transformers supplying the machine.**Tape: Adhesive, Insulating, Proofed, Rubber, and Terebo.** See **ADHESIVE TAPE, INSULATING TAPE, etc.****Taper-Loaded Cable.** A loaded submarine cable designed particularly for duplex working in which the end lengths are without added induc-

- tance and the loading is gradually increased towards the centre.
- Taper Slots.** Slots in an armature core in which the teeth have parallel sides. Cf. PARALLEL SLOTS and RADIAL SLOTS.
- Tappet Switch.** A switch actuated mechanically by a tappet due to the movement of some mechanism.
- Tappings.** Connections taken from intermediate points in a winding, such as that of a transformer or auto-transformer, to obtain different voltages, or from an armature winding for connection to slip-rings, as in a rotary converter or machine for connection to a compensator balancer.
- Target** (in an "X" Ray Tube). See ANTI-CATHODE.
- Target Diagram.** A form of diagram used to judge of the uniformity of a batch of incandescent lamps under test by plotting candle power against watts as a spot for each lamp, the degree of uniformity being represented by the area within which the group of spots lie.
- Tasimeter.** An instrument invented by Edison for measuring small differences of temperature by the alteration of pressure due to the expansion of a hard rubber strip on the equivalent of a carbon microphone.
- Taste, Galvanic.** See GALVANIC TASTE.
- Tau (τ).** Symbol for *Transmission Factor* (the Luminous Flux) or *Temperature*.
- Taylor Connection.** An arrangement for three- to two-phase transformation (and *vice versa*), in which the four two-phase connections are taken respectively from one apex, the centre of the opposite branch, and tappings near the ends of the other two branches of a delta-connected transformer.
- Teaser Transformer.** See SCOTT CONNECTION.
- Teaser.** See MONOCYCLIC ALTERNATOR.
- Teaser Winding:** (1) An old-fashioned name for a *Field Winding*. (2) An auxiliary winding on a transformer, etc., for regulation purposes. See MONOCYCLIC SYSTEM.

- Tee.** A T-shaped *Coupler* for connecting a length of conduit at right angles to a straight-through joint.
- Tee Joint.** A joint in a cable, etc., where a branch is taken off at right angles without cutting the main cable.
- Teeth:** Detachable and Dovetail. See ARMATURE TEETH, DETACHABLE TEETH and DOVETAIL TEETH.
- Telautograph.** (1) The original form of the writing telegraph instrument of Elisha Gray, the modern commercial form of which is known as the *Telewriter*. The movement of a pencil in the transmitting apparatus in an up and down direction regulates the current in one circuit by cutting resistance in and out, and its movement in a transverse direction regulates the current in another circuit. These two components of the movement of the pencil are re-combined at the receiving instrument by means of two moving coil galvanometers which control the vertical and transverse movement of a pen, according to the strengths of the currents in the two circuits, thus reproducing the movement of the transmitting pencil. (2) The *Korn* apparatus for transmission of photographs, etc., telegraphically is also sometimes called a "Telautograph."
- Telautography.** The transmission of images by telegraphic means, particularly applied to wireless methods.
- Telecord.** A form of recording phonograph which can be connected to a telephone.
- Telectal.** An aluminium alloy containing lithium, of high tensile strength, suitable for transmission lines.
- Telectrograph.** A system of *Phototelegraphy* in which the original is composed of lines on a metal base prepared by photographing through a single line screen on a bichromated film. A metal stylus passes over this and makes contact with the metal base in the parts corresponding to the dark portions of the picture, so that a current is sent over the line. The synchronously moving paper in the

receiving apparatus is chemically prepared, so that a coloured mark is produced electrolytically whenever a current passes through the paper from the stylus to the metal drum on which it is mounted.

Teletroscope. An early experimental *Television* apparatus due to Sienkocq (1877).

Telefunken System (of Wireless Telegraphy). The name given to various successive systems developed by the principal German wireless telegraph company; more particularly to a system employing a *Quenched Spark Gap*, giving a *Singing Spark* of a fairly high note.

Telegraph. Any system of conveying messages by signals over a distance. Formerly applied to semaphore and other visual systems, but now almost entirely to electrical systems. See TELEGRAPHY. The term is, however, still used for apparatus of a non-electrical as well as of an electrical nature for conveying orders from a ship's bridge to the engine room and other parts of the vessel and similar purposes. See references under TELEGRAPH SYSTEM and TELEGRAPHY.

Telegraph Cable. A single or multicore cable for telegraph purposes, laid underground or under water. See SUBMARINE CABLE.

Telegraph Circuit. The circuit over which signal currents are sent, in a telegraph system, between the transmitting apparatus and the receiving apparatus; usually consisting of an overhead line or cable and a return path through the earth. Various methods exist by means of which more than one message can be sent at a time through a single telegraph circuit. See DIPLEX, DUPLEX, MULTIPLEX, CARRIER WAVE, SUPERPOSED CIRCUIT, etc.

Telegraph Instrument. The actual apparatus used in telegraphy for modifying the current so as to give the required series of impulses corresponding to the message, or for enabling the signals to be observed at the receiving station.

Telegraph Line. The insulated portion of the telegraph circuit, which con-

nects the transmitting apparatus with the receiving apparatus; usually applied to an overhead line as distinct from a cable.

Telegraph Pole. A pole, usually of wood, treated with a preservative such as creosote, for the support of one or more overhead telegraph lines. See POLE, "A" POLE, and "H" POLE.

Telegraph Receiver. An instrument for the detection, indication, or recording of telegraph messages. Cf. TELEGRAPH TRANSMITTER.

Telegraph Relay. A *Relay* used for detecting weak signal current impulses, and causing corresponding stronger impulses to be sent in a local circuit containing the receiving apparatus. See POLARISED RELAY and other references under RELAY.

Telegraph Repeater. A form of relay used at an intermediate point in a long telegraph line to detect faint or distorted messages and to retransmit them automatically in a clearer form over a further section of the line. See REPEATING STATION and REPEATER.

Telegraph System: A.B.C. (Wheatstone), Audio-Frequency, Bain's Chemical, Baudot, Baudot Multiplex, Bridge Duplex, Creed, Delaney Multiplex, Dial, Differential Duplex, Diplex, Double Needle, Duplex, Five-Needle, Four Channel Duplex, Hughes, Mercadier-Magunna, Multichannel, Multiplex, Morse, Morse-Multiplex, Multiple Way, Multiplex, Multiway, Murray, Phonoplex, Printing, Multiplex, Quadruplex, Simplex, Single, Current, Single Needle, Steljes, Subaudio-frequency, Supra-Acoustic, Synchronous, Telemixte, Teletype, Tone-Frequency, Triplex, Type-Printing, Voice Frequency, Wheatstone Automatic, and Writing. See A.B.C. (Wheatstone) TELEGRAPH SYSTEM, AUDIO-FREQUENCY TELEGRAPH SYSTEM, etc. See also references under TELEGRAPHY.

Telegraph Transmitter. An instrument used to modify the current in a telegraph circuit so as to give the required series of impulses corresponding to the message;

consisting principally of a *Key*, or other contact or contacts, opened and closed rapidly in accordance with the required signals, either by hand or by special mechanism. Cf. TELEGRAPH RECEIVER.

Telegraph Wire. (1) A wire supported on insulators on poles, or otherwise, for the transmission of telegraph currents. (2) Wire of the quality used for this purpose, of iron, copper, or bronze.

Telegraphphone. An electrical apparatus by means of which sound may be recorded and subsequently reproduced in audible form. In the *Poulsen Telegraphphone*, a band of hard steel travels through the field of an electromagnet through the coils of which the received telephone current flows, and magnetised patches are produced in it corresponding to the sound waves. To reproduce the message, the magnetised band is passed through a coil connected to a telephone receiver, when it induces (owing to the changes of flux produced) varying currents corresponding to the original sound waves of the original message. The name has also been appropriated for an apparatus which automatically records the number of a caller at the called station when no answer is made.

Telegraphy. The sending of messages by signals consisting of a series of current impulses in a circuit connecting two places at some distance apart, or by trains of electric waves or otherwise, according to a code. Cf. TELEPHONY.

Telegraphy: *Carrier-Wave, Earth-Conduction, Facsimile, High Speed, Line, Photo-, Picture, Radio-, Space, Submarine, and Wireless.* See CARRIER CURRENT TELEGRAPHY, EARTH CONDUCTION TELEGRAPHY, etc. See also references under TELEGRAPH SYSTEM.

Telehor. An experimental *Television* apparatus for small pictures designed by Mihaly in 1922.

Telemeter. Although usually meaning an optical or other instrument for measuring distance, this term is sometimes used for an instrument for indicating current, voltage, etc.,

at a remote point, or for an electrical apparatus for distant reading of mechanical instruments.

Telemixte System. A system for working *Teletype* apparatus on ordinary telephone exchange lines.

Telephone. An apparatus by means of which sound waves such as those of the human voice can be made to produce variations in an electric current which, when received in an instrument some distance away, can produce sound waves reproducing the original sounds with sufficient accuracy for spoken words to be clearly distinguished. The original instrument of Reis (1860) bearing the name telephone was limited to the reproduction of musical sounds. Intelligible speech was not transmitted till Bell's instrument was produced in 1876. See TELEPHONE RECEIVER and TELEPHONE TRANSMITTER.

Telephone: *Bell, Bridging, Edison Loud-Speaking, Electro-adhesion, Electrostatic, Hot-Wire, Intercommunication, Radio-, Reed Type, Thermal, and Wireless.* See BELL TELEPHONE, BRIDGING TELEPHONE, etc.

Telephone Cable. A cable containing conductors for use as telephone circuits. Such cables for underground circuits are usually of the *Dry-Core* or *Air-Space* type, with the two wires forming each circuit twisted together, to minimise capacitance and liability to interference between the different circuits in the same cable. *Submarine* telephone cables are insulated with gutta percha, and in many cases are provided with *Loading Coils* or *Continuous Loading* to minimise *Distortion*. The distance over which a telephone cable is practicable has also been greatly extended by the use of *Repeaters*, and when used for broadcast relays, where quality is important, by *Corrector Circuits*.

Telephone Circuit. The circuit over which speaking and signal currents are sent in a telephone installation between the two stations in communication, usually consisting of two insulated conductors, as earth returns are now rarely employed

in telephony. The circuit can consist of overhead lines or underground or submarine cables. A large number of such circuits can be included in one cable. See also **PHYSICAL CIRCUIT**, **PHANTOM CIRCUIT**, **SIDE CIRCUIT**, **CARRIER-CURRENT**, **SUPERPOSED CIRCUIT**, etc., for methods by which the equivalent of more than one circuit per pair of wires can be obtained.

Telephone Condenser. A small condenser placed in parallel with a telephone receiver with the object of providing a by-pass to the higher frequencies.

Telephone Exchange. An establishment to which all the lines from the subscriber's apparatus in one district are connected; and where, on receipt of calls, they can be connected to any other subscriber's line that may be required, or through *Junction*, *Toll* or *Trunk Lines* to other exchanges, where connection is made to the required *Subscriber's Line*. Such connections are either made by hand through the medium of suitable *Switchboards* or by automatic apparatus put in action by signals made by the calling subscriber. See references under **TELEPHONE SYSTEMS**.

Telephone Interference Factor (of a Power Circuit adjacent to a Telephone Line). The ratio of the *Equivalent Disturbing Voltage* to the fundamental voltage of the circuit.

Telephone Jack. See **JACK**.

Telephone Line. One or more telephone circuits running along a particular route, usually confined to an overhead line supported on poles, as distinct from cables.

Telephone Meter. A step by step counting instrument actuated electromagnetically through a relay by means of a key, for registering the number of calls carried by a telephone circuit; also called *Call Meter* and *Register*.

Telephone Operator. See **TELEPHONIST**.

Telephone Pair. An expression often used for a single pair of wires in a

multiple cable or otherwise forming one metallic telephone circuit.

Telephone Receiver. The actual instrument in which the variations of the current received over a telephone line are caused to reproduce the sound waves corresponding to the words spoken into the *Transmitter*. See references under **RECEIVER**.

Telephone Relay. An apparatus for producing variations in a local current corresponding to, but much more powerful than, those of a received telephone current. See **BROWN TELEPHONE RELAY**. Cf. **TELEPHONE REPEATER**.

Telephone Repeater. An apparatus used at an intermediate point in a long telephone line to produce a current in the further portion of the line having variations corresponding to, but much stronger than, those of the current received over the first portion of the line. The telephone repeaters now in use are chiefly of the *Thermionic Valve* type acting as *Amplifiers*. The use of such apparatus enables economy in copper to be obtained by the employment of lighter lines, and the inductive *Loading* which would otherwise be necessary to be reduced or to be dispensed with.

Telephone Switchboard. A switchboard at a telephone exchange, or at an installation where a number of lines are dealt with, provided with the necessary apparatus and connections for receiving incoming calls from subscribers' lines, other exchanges, etc., and making connections with the required lines.

Telephone Switching. The whole subject of interconnection of telephone circuits and telephone exchange working.

Telephone System: **Automatic**, **Automatic**, **Central Battery**, **Common Battery**, **Local Battery**, **Machine Switching**, **Magneto**, **Manual**, **Semi-Automatic**, and **Straightforward Junction**. See **AUTOMATIC TELEPHONE SYSTEM**, **AUTOMANUAL TELEPHONE SYSTEM**, etc.

Telephone Terminal. See **BINDING POST**.

Telephone Traffic Unit. See **TRAFFIC UNIT**.

Telephone Transformer. See OUTPUT TRANSFORMER.

Telephone Transmitter. The actual instrument whereby the sound waves of the words spoken are caused to produce modulations of the current sent over the line which cause the *Receiver* to reproduce the original sounds. See MICROPHONE and references under TRANSMITTER.

Telephonic Repeater. See TELEPHONE REPEATER.

Telephonist Release. A system requiring the intervention of a telephonist (operator) to clear the lines. Cf. CALLING PARTY RELEASE.

Telephonograph. An instrument for recording messages received by telephone on a phonograph.

Telephonometry. Practical quantitative testing and measurement relating to telephone circuits and apparatus.

Telephony. The reproduction at a distant point of spoken words or other sounds by electrical or other means, with or without a connecting wire. Cf. TELEGRAPHY.

Telephony: Bi-Band, Line, Optical, Quiescent Carrier, Radio-Side Band, Single Side Band, Space, Submarine, Suppressed Carrier Wave, Two-Band, Wave, and Wireless. See BI-BAND TELEPHONY, LINE TELEPHONY, etc.

Telephoto. A name applied many years ago to proposed *Television* apparatus (see also PHEROPH), and later applied to a particular form (due to Dauvillier) employing an exploring beam actuated by vibrating mirrors controlled by tuning forks in the transmitter and a form of *Cathode Ray Oscillograph* as the receiver. See also RADIOPHOTO.

Telephotophone. See PHOTOPHONE.

Teletypewriter. A simplified form of start-stop printing telegraph instrument with a typewriter keyboard for transmission, and a motor-driven tape printing receiver; suitable for working on telephone lines now largely used in the British Post Office Telegraphs.

Teletypewriter, Ultra-acoustic. See ULTRA-ACOUSTIC TELETYPEWRITER.

Telescope (Electric). The name given to an early experimental television

apparatus (due to Nipkow, 1884), in which the object was scanned by a beam controlled by a rotating disc perforated with a spirally arranged series of holes and depending upon the deflection of light by a Nicol prism in a magnetic field for the action of the receiving apparatus.

Telescope, Electron. See ELECTRON TELESCOPE.

Teletestereograph. A name sometimes given to the *Belin System of Phototelegraphy*.

Telethermometer. An apparatus for indicating or recording temperatures in an instrument at a considerable distance away. See THERMOMETER (Electric).

Teletype. A *Type Printing Telegraph* instrument for a single conductor system similar to the *Baudot* system, but using a keyboard transmitter, and for a type of *Start-Stop Printer*.

Teletypewriter. See TELETYPEWRITER.

Television. The reproduction of visible images of moving objects at a distant station by electrical means. Apparatus for this purpose is at present in a more or less experimental stage. In an elementary form of the transmitting apparatus a beam of light, moving rapidly in two dimensions, is made to "scan" the object, and the variation in light reflected causes variations in the current through photo-electric cells. These variations of current, suitably amplified, modulate the waves sent out and in the receiving apparatus, control the strength of a synchronously moving beam of light so that a similar image is produced upon a screen. See also TELEVISION TRANSMITTER, TELEVISION RECEIVER, CATHODE RAY TELEVISION, ICONOSCOPE, SCANNING, etc., and references below.

Television: Cathode Ray, High Definition, Line, Low Definition, Multi-channel, and Wireless. See CATHODE RAY TELEVISION, HIGH DEFINITION TELEVISION, etc.

Television Receiver. An apparatus for reproducing visual images by television. In small screen high definition apparatus, usually employing the cathode ray system.

Other methods employ a moving beam of light controlled in intensity by a *Light Relay* and in position by moving slots, lenses, or mirrors.

Television Transmitter. The whole equipment for transmitting wireless signals for television usually employing very short wavelengths.

Televisor. A name given to an early class of *Television* apparatus.

Telewriter. See *TELAUTOGRAPH*.

Telex. A voice-frequency Teleprinter system, used in the British Post Office for special subscribers in connection with the telephone.

Telpherage. The conveyance of goods, etc., by vehicles suspended from small wheeled trucks running on a single overhead rail or ropeway and propelled by an electric locomotive truck of similar nature, taking current either from contacts at each end of the train making contact with sections of the live supporting cable at opposite polarity, or from an independent contact line; and either with or without a driver on the train.

Temperature, Critical and Neutral. See *CRITICAL TEMPERATURE* and *NEUTRAL TEMPERATURE*.

Temperature Coefficient (of Resistance). The proportional change of resistance of a conductor for 1° change of temperature. This quantity may be positive, as in most metals, or negative, as in carbon, and is not constant at different temperatures, except approximately in some cases of pure metals.

Temperature Radiation. Radiation of energy from a body due to the fact that it is at a higher temperature than the surrounding medium. Cf. *LUMINESCENCE*, etc.

Temperature Rise. In testing dynamo electric machinery, transformers, etc., the rated output is usually determined by that which the apparatus can deal with without its temperature rise exceeding a certain specified amount after a specified period.

Temperature Rise, Specific. See *SPECIFIC TEMPERATURE RISE*.

Temperature Switch. A switch, in a control circuit, etc., actuated through thermostats by changes of

temperature. Such apparatus can be used to shut down overloaded machines, etc., automatically, or to start up spare plant on the load rising.

Tension. An expression often used for *Difference of Potential*, *Electromotive Force*, *Voltage*, or *Pressure*.

Tension: Extra High, High, and Low. See *EXTRA HIGH TENSION*, *HIGH TENSION*, etc.

Tension Insulator. See *STRAIN INSULATOR*.

Tension Joint. A joint between conductors in an overload line, etc., designed to take mechanical tension, as well as to transmit the full current. Cf. *NON-TENSION JOINT*.

Teredo Tape. A sheathing of brass tape placed over the core of a submarine cable as a protection against damage to the insulation by a small submarine animal called the "Teredo," which is apt to bore minute holes in the gutta-percha.

Terminal. Fittings attached to the electrodes, or the opposite ends of the windings, etc., of electrical apparatus, installations, etc., for the reception of connections to other parts of the circuit.

Terminal(s): Bottom Loop, Condenser Type, Consumer's, Earthed, and Test. See *BOTTOM LOOP TERMINALS*, *CONDENSER TYPE TERMINALS*, etc.

Terminal Bar (of an Accumulator). A bar to which all the lugs of the plates of one polarity are attached.

Terminal Block or Board. A small block or board attached to a machine or apparatus, upon which the terminals are mounted.

Terminal Box. A box containing a *Terminal Block or Board*.

Terminal Impedance. The impedance of the apparatus, circuits, etc., at the sending or receiving end of a telephone line, as distinct from the impedance of the line.

Terminal Insulator. (1) An insulator upon which a terminal is mounted to insulate it from the case of a piece of apparatus such as a high tension transformer. (2) An insulator at the end of an overhead line which takes the pull of the

- wire as well as insulating it. See **TERMINAL POLE**.
- Terminal Limit Switch.** A *Limit Switch* on an electric lift which stops the car at or near a terminal landing. See also **FINAL LIMIT SWITCH**.
- Terminal Noise.** Any disturbing *Noise* in a telephone receiver due to causes at the sending and receiving ends, e.g. room noises, *Side Tone*, etc. Cf. **LINE NOISE**.
- Terminal Pole.** A pole at the end of an overhead line, specially strengthened to take the pull of the wires.
- Terminal Screw.** See **BINDING SCREW**.
- Terminal Switch.** See **LIMIT SWITCH**.
- Terminal Voltage.** The actual difference of potential at the terminals of a machine, apparatus, or installation, after the effect of the voltage drop, etc., has been allowed for.
- Terrella.** A sphere of natural lodestone (from about 1 to 4 inches diameter) used, particularly in the seventeenth and eighteenth centuries, by Gilbert and others, as a reduced model of the earth to study the distribution of *Terrestrial Magnetism*. (Also called *Microg.*)
- Terrestrial Magnetism.** The magnetic field due to the fact that the earth acts as a complete permanent magnet, with poles in the neighbourhood of, but not exactly at, its geographical North and South Poles; causing the directive power of the *Compass*. See **INCLINATION**, **DECLINATION**, **HORIZONTAL COMPONENT**, **VERTICAL COMPONENT**, **DIURNAL**, **ANNUAL** and **SECULAR VARIATION**, **MAGNETIC MAPS**, **ISOCLINIC**, **ACLINIC**, **ISOGONIC**, and **AGONIC LINES**, etc.
- Tertiary Winding.** A winding in a transformer additional to the primary and secondary windings for any purpose, e.g. to prevent excessive third harmonics and to stabilise the neutral potential, to provide an auxiliary supply at another voltage or to make connection with a power-factor compensating apparatus.
- Tesla Coil or Tesla Transformer.** A transformer for high frequency currents without an iron core and with the windings immersed in oil; usually arranged so that the windings form parts of oscillating circuits.
- Tesla Current.** A term used in *Diathermy* for a comparatively heavy high frequency current at a high voltage. Cf. **OUDEIN CURRENT** and **D'ARSONVAL CURRENT**.
- Test:** **Air-Calorimeter**, **Allen's**, **Blavier's**, **Conductivity**, **Drop**, **Engaged**, **Fall of Potential**, **Flash-Over**, **Heating**, **High Voltage**, **Hopkinson**, **Ikeida**, **Insulation**, **Life**, **Loop**, **Murray's**, **Overlap**, **Ratio**, **Short Circuit**, **Spark-Over**, and **Varley's**. See **AIR-CALORIMETER TEST**, **ALLEN'S TEST**, etc.
- Test Board.** (1) A board arranged with suitable instruments, switch-gear, and connections so that apparatus may be readily connected thereto for testing purposes. (2) A board containing terminals or jacks to which connections are brought from instruments, circuits, etc., for convenience in testing.
- Test Box.** An enclosed form of *Test Board*.
- Test Buzzer.** See **BUZZER**.
- Test Jack.** A *Jack* for making connections for routine telephone testing.
- Test Shield.** A metal sheath over the main insulation of a cable, insulated from the protective sheathing, if any. Cf. **EARTH SHIELD**.
- Test Surface** (in Photometry). A surface illuminated by the source under test.
- Test Terminals.** Terminals connected to suitable points in circuits or apparatus and mounted on convenient test-boards, etc., for ready connection of testing apparatus.
- Tester:** **Cell**, **Hysteresis**, **Insulation**, and **Magnetic**. See **CELL-TESTER**, **HYSTERESIS TESTER**, etc.
- Testing:** **Insulation**, **Joint**, and **Magnetic**. See **INSULATION TESTING**, **JOINT TESTING**, etc.
- Testing Bush.** See **BUSH**.
- Testing Set.** A self-contained compactly arranged collection of all the necessary apparatus required to make a particular test, such as that of *Insulation*. See **MEGGER**.
- Testing Transformer.** A transformer for providing a high potential for testing purposes.

Testing Wire (in Telephony). See "S" WIRE.

Tetrasdon. A fish found in the South Atlantic capable of giving electric discharges physiologically.

Tetrode. See FOUR ELECTRODE VALVE.

Tetrode Multiplex. See MORSE MULTIPLEX SYSTEM.

Thalofide Cell. A *Photoelectric Cell* in which the active material is thallium sulphide in a vacuum. Used in *Sound Film* and *Television* apparatus, and particularly sensitive to infra-red rays.

Theatre Main. A special *Main* provided to form an alternative source of supply to theatres in case of a failure of supply through the ordinary mains of the district. Often arranged with an automatic switch, so that connection is made to it immediately the ordinary supply fails, or *vice versa*.

Theatrophone. A system similar to that described under *Electrophone*.

Therapy: Actino-, Electro-, Infra-Red, Physio-, Radiant Heat, Radio-, Short Wave, Sinusoidal, and Ultra-Violet. See ACTINO-THERAPY, ELECTROTHERAPY, etc.

Thereminvox. See ETHEROPHONE.

Thermal Agitation Voltage. An irregular succession of minute voltage impulses in a conductor due to interval of free electrons between their collisions, producing a perceptible background noise in wireless receivers with very high amplification.

Thermal Ammeter. See HOT WIRE INSTRUMENTS.

Thermal Circuit-Breaker. A circuit-breaker arranged to be released and to open the circuit by the melting of a fuse, or by the expansion of a metal piece due to heating by an excess current.

Thermal Conductivity. The reciprocal of *Thermal Resistivity*.

Thermal Cross. An arrangement for measuring small alternating currents, consisting of a cross formed by wires of two dissimilar metals connected at the centre. The current passes through two dissimilar branches, heating the junction and producing a unidirectional thermoelectric e.m.f. which de-

flects a galvanometer connected to the other two branches or corners of the square.

Thermal Cut-Out. A thermal *Circuit-Breaker* of small size, or an ordinary *Fuse*.

Thermal Detector. A detector of electrical oscillations depending upon their heating effect, e.g. the *Burrletter*.

Thermal Flasher. A *Flasher* in which the circuit remains closed when the apparatus remains cold, but is opened as soon as sufficient expansion of parts thereof is caused by the heating effect of the current. The circuit closes after cooling, and so on.

Thermal Instruments. Measuring instruments depending on the heating effect of the current; including *Thermo-Couple Instruments* and *Hot Wire Instruments*.

Thermal Limit (of Output). The maximum output which a machine can deal with without exceeding specified limits of temperature rise; higher in some cases than the *Sparking Limit*.

Thermal Ohm. An expression used by some writers for a unit of resistance to the flow of heat through a piece of material, being that which allows a flow of heat at the rate of one watt between opposite faces of a centimetre cube of the material when the difference of temperature is 1° C.

Thermal Receiver. A telephone receiver in which the sound waves are reproduced either by the movements of the diaphragm, controlled by the variations of expansion of a wire heated by the telephone current, or by direct expansion and contraction of the air, due to the heating and cooling of the air, entirely without a diaphragm. Also called *Hot Wire Telephone*.

Thermal Relay. See THERMO-RELAY.

Thermal Resistance. The resistance offered by a body to the flow of heat through it. Most conveniently measured in relation to the cooling of electrical apparatus by the drop in degrees C. per watt transmitted per unit area.

Thermal Resistivity. *Thermal Resistance* per unit length of unit area.

Thermal Station. A *Generating Station* in which the plant is driven by steam or internal combustion engines.

Thermal Storage Heating. A system of electric heating in which hot water, heated electrically at times of light load in boilers having considerable heat capacity, is circulated in ordinary pipes and radiators.

Thermal Telephone. See THERMAL RECEIVER.

Thermal Time Constant. See TIME CONSTANT.

Thermautostat. An automatic heat-regulator in which the same set of resistors serve as thermometer resistance and heating elements, controlled by variation of the phase of an alternating current by a *Thyatron*, the grid voltage of which is controlled by a light-sensitive cell receiving the beam from a bridge galvanometer.

Thermel. A name given to an electric thermometer of the thermo-electric type.

Thermionic Amplifier. A *Thermionic Valve* used as an *Amplifier* or *magnifier* of the scale of the modulations of a telephone current, or trains of oscillations in wireless telegraphy or telephony, by taking advantage of the fact that, under suitable conditions, small variations of c.m.f. applied between the *Cathode* and the *Grid* produce large variations in the current in the *Anode* (or *Plate*) *Circuit*. Several such valves may be used in cascade, i.e. with the *Plate Circuit* of one coupled, inductively or otherwise, to the *Grid Circuit* of the next, so that several successive stages of amplification are produced. Such apparatus is extensively used in wireless telegraphy and telephony, as well as in *Repeating Stations* on long distance telephone lines.

Thermionic Current. The current carried by electrons or ions through a *Thermionic Valve*.

Thermionic Detector. A *Thermionic Valve* used as a *Detector* of electrical oscillations in wireless telegraphy and telephony, either in its original two-electrode form (see

OSCILLATION VALVE), acting simply as a *Rectifier* in series with the receiving telephone, and thus enabling the oscillations to affect the diaphragm, or in its later and more usual three-electrode form, by the *Anode Bend* or by the *Cumulative* (grid leak) methods of *Rectification*.

Thermionic Emission. The emission of a stream of negative electrons or ions from a heated cathode in a vacuum tube. See THERMIONIC VALVE.

Thermionic Generator. See THERMIONIC OSCILLATOR.

Thermionic Magnifier. An apparatus for increasing the strength of signals received over submarine cables in which the moving coil carries a second winding in which minute c.m.f.'s are induced and act on the grid of a thermionic amplifier valve. In another form, movement of a vane attached to a moving coil varies the capacitance coupling to the grid of two thermionic valves and thus affects their output.

Thermionic Oscillator. A *Thermionic Valve*, used as a generator of *Continuous Oscillations*, by suitable coupling of the grid circuit to the tuned *Plate Circuit*.

Thermionic Rectifier. A *Thermionic Valve* used as a *Rectifier*.

Thermionic Relay. A *Thermionic Valve* used to perform the function of a *Relay*.

Thermionic Tube. See THERMIONIC VALVE.

Thermionic Valve. A *Discharge Tube* with a *Cathode* formed by a heated filament, usually of tungsten, with or without the addition of other material or independently heated, and a sheet metal *Anode*, called the *Plate*, upon which a stream of negative electrons is projected from the hot cathode when a sufficient continuous c.m.f. is applied across the tube. In its original form with two electrodes, such a tube can be employed as a rectifier, and consequently as a detector. See OSCILLATION VALVE. In most cases a third or *Control Electrode*, in

the form of a *Grid* or net of wire, is employed as a screen between the filament and the plate. Variations in the potential of this grid have a controlling effect upon the stream of electrons between the filament and the plate, i.e. upon the current through the tube of such a character that, within a certain range, a small change in the grid voltage produces a large change in the plate current. Such tubes can be employed, not only as *Detectors* but also as *Amplifiers* and as *Oscillators*, and since their introduction, have revolutionised all the methods of wireless telegraphy, and more particularly of *Wireless Telephony*. See THERMIONIC AMPLIFIER, THERMIONIC DETECTOR, THERMIONIC OSCILLATOR, DIODE, TRIODE, RECTIFICATION, etc., and references under VALVE.

Thermionic Voltmeter. An instrument for measuring small voltages, by observing the change in anode current produced in a *Thermionic Valve*, when applied between the cathode and the *Grid*.

Thermionic Wattmeter. An apparatus for measuring power in a circuit, in the simplest form of which the sum of and the difference between the potential drops across a resistance in the main circuit, and a portion of a shunt across it, are applied to the grid of two thermionic valves, so connected that the power in the main circuit is proportional to difference between their anode currents, which is read on a differential galvanometer.

Thermions. Ions emitted by the heated cathode of a *Thermionic Valve* tube.

Thermo-Ammeter. An ammeter on the same principle as the *Dudell Thermo-Galvanometer*.

Thermo-Chemical Generator. An apparatus for producing an e.m.f. from chemical actions at a high temperature, e.g. for obtaining electrical energy directly from coal; existing at present only in experimental forms.

Thermo-Converter. A self-contained combination of heating resistance

and thermo-couple enabling an ordinary multi-voltmeter to be used as a thermo-couple instrument for high frequency purposes.

Thermo-Couple. See THERMO-ELECTRIC COUPLE.

Thermo-Couple Instruments. Instruments depending on the heating of a thermo-couple by the current to be measured, e.g. *Thermo-Galvanometer*, *Thermo-Ammeter*, etc.

Thermo-Couple Thermometer and Pyrometer. See THERMO-ELECTRIC THERMOMETER and PYROMETER.

Thermo-Detector. See THERMAL DETECTOR.

Thermo-Electric Couple. A pair of metals forming a *Thermo-Electric Junction*.

Thermo-Electric Current. A current caused to flow in a circuit by an e.m.f. produced by a difference of temperature between a junction of two dissimilar metals forming part of the circuit, and other parts of the circuit. See SEEBECK EFFECT.

Thermo-Electric Effect. The e.m.f. arising from the heating of dissimilar metals. (Also called *Seebeck Effect*.)

Thermo-Electric Element. One of the two pieces of different metals forming a *Thermo-Electric Junction*.

Thermo-Electric Generator. An apparatus for generating electric currents by heating the junctions of dissimilar metals. See THERMO-PILE.

Thermo-Electric Height. See THERMO-ELECTRIC POWER.

Thermo-Electric Inversion. The reversal of the direction of a thermo-electric current between a particular pair of metals above the temperature known as the *Neutral Temperature* for the two metals in question.

Thermo-Electric Junction. A contact surface between two different metals forming part of an electric circuit, which, when maintained at a different temperature from the contacts of the other ends of the pieces in question (with each other or with other parts of materials completing the circuit), will produce an e.m.f. which can cause a current to flow in the circuit deriving

its energy from the source of heat maintaining the difference of temperature.

Thermo-Electric Line. A curve (usually a straight line) showing the e.m.f. produced between a particular metal and a standard metal, such as lead, when a junction composed of the two is heated to the temperatures against which it is plotted, while the other junction is maintained at 0° C.

Thermo-Electric Pile. See THERMO-PILE.

Thermo-Electric Power. The electromotive force per degree (C.) produced by heating a thermo-electric junction between a particular metal and the standard metal lead. Sometimes called *Thermo-Electric Height*.

Thermo-Electric Pyrometer. A *Thermo-Electric Thermometer* for high temperatures.

Thermo-Electric Series. A table of metals arranged according to their *Thermo-Electric Power*.

Thermo-Electric Thermometer. An instrument for measuring high temperatures by observing, with a galvanometer or otherwise, the e.m.f. produced in a *Thermo-Electric Junction* heated to that temperature, while the corresponding reverse junction is kept at a known low temperature. The metals used are often platinum and an alloy of platinum and rhodium.

Thermo-Electricity. The phenomena of thermo-electric currents and the differences of potential producing them. See SEEBECK EFFECT, Peltier Effect, Thomson Effect, THERMO-ELECTRIC INVERSION, NEUTRAL TEMPERATURE, etc.

Thermo-Electromotive Force. An e.m.f. due to the heating of a junction of dissimilar metals.

Thermo-Expansion Instruments. See HOT WIRE INSTRUMENTS.

Thermo-Galvanometer. A sensitive instrument for the measurement of small alternating or direct currents, used particularly in wireless telegraph testing. The current to be measured passes through a short fine wire of high resistance, in which it produces an appreciable

heating effect. Hanging immediately over this heater is a thermo-junction, attached to and in the circuit of the moving coil of a delicate galvanometer, which is deflected by the thermo-electric current produced.

Thermo-Generator. See THERMOPILE.

Thermo-Junction. See THERMO-ELECTRIC JUNCTION.

Thermo-Magnetic Generator. An apparatus in which currents are induced by changes in magnetic induction produced by the alternate heating and cooling of a magnet. Existing at present only in experimental form.

Thermometer (Electric). An instrument for measuring temperatures by electrical means, such as by the alteration of resistance of a wire of platinum or other material, or by the e.m.f. produced in a thermo-couple. See RESISTANCE THERMOMETER, THERMO-ELECTRIC THERMOMETER, CALLENDER RECORDING BRIDGE, etc.

Thermometer, Resistance. See RESISTANCE THERMOMETER.

Thermophone. See THERMAL TELEPHONE.

Thermopile. An apparatus for obtaining electrical energy direct from heat; consisting of a number of thermo-electric junctions in series, arranged so that their alternate ends can be kept hot and cold respectively. Such an apparatus deteriorates somewhat with prolonged use and is not employed on a commercial scale, although it is of use for experimental purposes, for radiation measurements, etc.

Thermo-Relay. An apparatus in which the movement of the beam from a delicate reflecting galvanometer falling upon a pair of opposed thermo-junctions upsets the balance of the heating effect on them resulting in an e.m.f. sufficient to produce, in a second galvanometer, a deflection much greater than in the first.

Thermostat. An apparatus for maintaining constancy of temperature, e.g. an electrical thermometer in which the indicating instrument is fitted with contacts which

control the heat supply through suitable relays, etc. There are also numerous forms of non-electrical thermostat.

Thermostatic Control. The actuation of switchgear, etc., in accordance with temperature conditions through the medium of a *Thermostat*, e.g. an arrangement for opening a circuit-breaker when the oil temperature of a transformer exceeds a certain limit, or when a hot bearing occurs, or for automatic control of heating apparatus to maintain constant temperature.

Thermo-Voltmeter. A voltmeter for alternating current on the same principle as the thermo-galvanometer, but with the thermo-couple separate from the moving system.

Thimble, Sweating. See SWEATING THIMBLE.

Third Class Conductor. Parts of circuits possessing *Negative Resistance* are sometimes spoken of as third-class conductors.

Third Harmonic. An expression now commonly used for a superposed sine wave of three times the fundamental frequency, but formerly used for the harmonic of four times the fundamental frequency, the fundamental itself not being counted as the first harmonic. See TRIPLE FREQUENCY HARMONIC.

Third Rail. An insulated rail provided in some electric railways, in addition to the two running rails, to serve as a *Conductor Rail* from which current is collected by the trains. Unless another conductor rail, or *Fourth Rail*, is provided, the return path is afforded by the track rails, which are efficiently *Bonded* for the purpose. Such conductor rails are not usually employed for pressures above 600 or 700 volts, unless specially protected. See CONTACT RAIL, TOP CONTACT RAIL, SIDE CONTACT RAIL, UNDER CONTACT RAIL, etc.

Third Rail Insulator. See CONDUCTOR RAIL INSULATOR.

Third Rail System. See CONDUCTOR RAIL SYSTEM.

Third Wire (in telephony). See "S" WIRE.

Thomas Transmission. A system of *Petrol Electric Transmission* in which the power at the higher speed ratios (lower "speeds") is transmitted, partly electrically and partly mechanically.

Thompson Permeameter. A form of *Traction Permeameter* designed by Silvanus P. Thompson.

Thomson Arrival Curve. See ARRIVAL CURVE.

Thomson Balance, Bridge, Compass, etc. See KELVIN BALANCE, BRIDGE, etc.

Thomson Effect. The production of an e.m.f. between portions of the same metal in a circuit at different temperatures, or, conversely, the evolution or abstraction of heat when a current flows from one portion of the same metal to another at a different temperature. Cf. THERMO-ELECTRICITY.

Thomson-Houston Arc Lighter. See ARC LIGHTER.

Thomson Meter. A type of integrating motor meter due to Elihu Thomson for alternating or direct current with no iron in its magnetic circuit. A series coil provides the field, in which rotates a fine wire armature with a commutator in the voltage circuit. The retarding torque is provided by an oddy-current brake.

Thomson-Varley Coils or Slide. A form of variable resistance considerably used in the earlier days of cable testing, etc., consisting of a large number of resistance coils connected between the adjacent contacts of two dial switches. One of these carried two parallel contact arms, making contact with two adjacent fixed contacts respectively, and connected across the whole resistance contained in the other box. This second rheostat is equal in value to one of the equal steps of the first, and its coils are spoken of as *Vernier Coils*, and form a fine adjustment after a rough adjustment has been arrived at by the first dial switch.

Thoriated Filament. An early form of filament for a *Thull Emitter Valve* into which thorium was incorporated during manufacture. Cf. OXIDE COATED FILAMENT.

Thousands Selector (in Automatic Telephony). A *Selector* responding to the impulses representing the first digit of a four-figure number dialled in a call, the function of which is to make connection, at the called exchange, between a *Junction Line*, selected by the *Junction Selector* at the calling exchange, and an appropriate *Hundreds Selector*.

Thread, Electrical Screw. The special screw thread used for screwed steel conduit.

Thread Recorder. A form of *Graphic* or recording instrument is caused to mark the chart at intervals through an impregnated thread (similar to a typewriter ribbon) by momentary pressure on to it.

Threaded-in Winding. A winding in closed or nearly closed slots in which the conductors are threaded in from the ends of the slots singly, each turn sometimes taking the place of one of a collection of temporary rods or "pins," employed to keep the conductors in place. Also called *Pin Winding*.

Threading. A method of installing *Interior Conduit Wiring* in which the separate sections of the conduit tube are threaded over the wires that they are to contain before they are put in place, instead of the complete conduit being erected first and the wires drawn in afterwards.

Three-Core Cable. A cable with three separately insulated conductors not arranged concentrically; used in preference to a *Triple Concentric* cable for three-phase circuits, on account of the unequal reactive effects between the respective cores in the latter.

Three-Electrode Valve. See *TRIODE*.

Three-in-One Valve. A *Thermionic Valve* with additional grids arranged so that it can be used simultaneously as a detector, high frequency amplifier and low frequency amplifier.

Three-Part Commutator. An obsolete form of commutator, used on small machines, consisting of three segments, formed by dividing a metal tube into three parts, each separately mounted on an insulating cylinder.

Three-Phase. Pertaining to an alternating current system where the circuit is divided into three branches or "Phases," the currents in which are displaced one from another in phase by 120° . See *STAR CONNECTION* and *MESH CONNECTION*.

Three-Phase Alternator. An alternator provided with three symmetrically arranged armature circuits in which e.m.f.'s. are induced differing in phase by 120° , i.e. producing *Three-Phase Currents*.

Three-Phase Commutator Motor. See *POLYPHASE COMMUTATOR MOTOR*.

Three-Phase Currents. Alternating currents flowing in the three branches of a Three-Phase System and displaced in phase from one another by 120° , thus reaching their maxima at different times in regular rotation.

Three-Phase Four-Wire System. A system of distribution of three-phase currents in which the generating plant is star connected, and a fourth, or neutral, wire is connected to the star point and taken throughout the system.

Three-Phase Generator. See *THREE-PHASE ALTERNATOR*.

Three-Phase Locomotive. A locomotive driven by three-phase induction motors; usually with two overhead lines and rail return. Such locomotives cannot exert power at a speed above synchronism, but are suitable for heavy gradients because, if they are run down hill slightly in excess of this speed, the motors act as regenerative brakes, returning power to the line. Arrangements are usually made for additional economical running speeds, lower than the synchronous speed, by changing the effective number of poles of the motors, coupling them in *Cascade*, or both. Otherwise the control is by resistances in the rotor circuits.

Three-Phase Meter. A meter for three-phase circuits consisting, when the load is assumed to be balanced, of a single induction meter in one phase, or if the load is unbalanced of two such movements

- connected as in the *Two-Wattmeter Method* actuating the same counting train.
- Three-Phase Motor.** A motor for running on three-phase currents, of the *Induction*, *Synchronous*, or *Commutator Type*.
- Three-Phase Railway.** See *THREE-PHASE LOCOMOTIVE*.
- Three-Phase Rotor.** A rotor of an *Induction Motor* with its winding in three symmetrically placed sections connected to three slip-rings; requiring the starting resistance to be in three sections varied together by a three-arm switch or otherwise.
- Three-Phase Six-Wire System.** See *SIX-WIRE THREE-PHASE SYSTEM*.
- Three-Phase Starter.** A starter for a three-phase *Induction Motor* with a three-branched rheostat for the *Rotor Circuit*.
- Three-Phase System.** A system where the circuit is divided into three branches, in which currents differing in phase by 120° from one another, i.e. by one-third of a period, circulate; reaching their maxima in regular sequence. See *STAR CONNECTION* and *MESH CONNECTION*.
- Three-Phase System: Balanced, Symmetrical, and Unbalanced.** See *BALANCED THREE-PHASE SYSTEM*, *SYMMETRICAL THREE-PHASE SYSTEM*, etc.
- Three-Phase Three-Wire System.** A three-phase system with one main for each phase only. Cf. *THREE-PHASE FOUR-WIRE SYSTEM*.
- Three-Phase Traction.** See *THREE-PHASE LOCOMOTIVE*.
- Three-Phase Transformer.** A transformer for three-phase currents with one iron core with three limbs, carrying the windings of the three respective phases. In some cases three separate single-phase transformers are used instead of one three-phase transformer.
- Three-Phase Winding.** A winding divided into three symmetrically disposed circuits for *Three-Phase Currents*.
- Three-Pin Plug.** A plug with three contact pins, e.g. for two line poles and an earth connection.
- Three-Point Switch.** A switch in

- which a single moving contact makes contact with any one of three fixed contacts alternatively. Usually applied to small switches. See *THREE-WAY SWITCH*.
- Three-Pole Switch.** The equivalent of three single-pole switches coupled together, e.g. a switch to open or close the three branches of a three-phase circuit simultaneously.
- Three-Range Winding.** See *RANGE*.
- Three-Tier Winding.** Another name for a *Three-Range Winding*.
- Three-Valve Receiver.** See *VALVE RECEIVER*.
- Three-Voltmeter Method.** A method of measuring the true power in an inductive alternating current (single phase) circuit, in which a non-inductive resistance (R) is placed in series with the inductive load, and three voltmeter readings are taken, across the whole circuit (V), the inductive load (V_1), and the non-inductive resistance (V_2). The true power in the circuit is then equal to $(V^2 - V_1^2 - V_2^2)/2R$.
- Three-Wattmeter Method.** A method of measuring the power in a three-phase four-wire circuit by adding together the readings of three wattmeters placed with their current coils in series with the three phases, and their pressure coils connected respectively between each phase and the fourth or neutral wire. Cf. *TWO WATTMETER METHOD*.
- Three-Way Switch.** A switch in which a single moving contact can make contact with any one of three fixed contacts alternatively.
- Three-Wire Balancer.** See *BALANCER*.
- Three-Wire Compensator.** See *COMPENSATOR BALANCER*.
- Three-Wire Distribution.** See *THREE-WIRE SYSTEM*.
- Three-Wire Dynamo.** A dynamo for supplying a three-wire system without a running balancer, such as one with two windings each with its own commutator, or a single winding and slip-rings for connection to a *Compensator Balancer*.
- Three-Wire Meter.** A *Supply Meter* integrating simultaneously the energy in the two sides of a three-wire system.
- Three-Wire System.** (1) A system of distribution used for direct

currents in which an intermediate conductor is provided throughout the system, maintained at a voltage intermediate between the positive and negative (or *Outer*) mains, and called the *Neutral* or *Inner Main* or the *Middle Wire*. This is sometimes earthed so that one outer main is above and the other below earth potential. A part of the load is connected between one outer main and the neutral, and part between the other outer main and the neutral, so that the neutral only carries the difference of the currents in the outers. By this means economy in copper in the mains is effected, and a distribution voltage double that which enters any one consumer's premises can be used. Part of the load can also be connected across the outers when the higher voltage is convenient, e.g. for motors. (2) See **TWO-PHASE THREE-WIRE SYSTEM**.

Three-Wire Transformer. See **BALANCE TRANSFORMER**.

Throttle Magnet. The electromagnet used on an electro-pneumatic switch to operate the air valve, which admits compressed air into the cylinder actuating the switch itself.

Throttle Switch. See **LIMIT SWITCH** (2).

Throw (of an Armature Coil). The distance apart of the two sides of a coil; usually expressed with reference to the slots which they occupy, thus if the slots are consecutively numbered, a throw of "one and eleven" would mean that the coil sides occupy slots Nos. 1 and 11.

Throw-Off Force. The force, due to the dynamic action of the current itself which, particularly in the case of heavy short circuits, tends to open a switch or circuit-breaker.

Throw-Over Switch. A single or multi-pole pole switch in which the moving contacts can make contact alternatively with more than one set of fixed contacts.

Thunder. The sound made by the disturbance of the air caused by a lightning discharge, due to the sudden expansion and contraction of the air in the path of the flash. Essentially a sudden bang or

"clap" like the report of a gun at close quarters, but usually with the addition of a rattle, due to the flash being irregular in its course with different parts at a different distance from the observer, and a rumble due to successive echoes or reflections of the sound from clouds or strata of air at different temperatures. Owing to the difference between the speeds of propagation of light and sound, the thunder reaches the ear about five seconds later than the reception of the flash by the eye for every mile of distance between the observer and the discharge.

Thunder-Bolt. A term formerly applied to a lightning discharge when it was thought to consist of a material projectile identical with the vitrified mass sometimes found in the ground where a discharge has gone to earth. See **FULGURITE**.

Thunder-Pump. An old-fashioned name for certain forms of hand-worked magneto generator.

Thunder-Storm. See **LIGHTNING** and **THUNDER**.

Thury Regulator. A form of automatic voltage regulator in which the rheostat arm is driven by a toothed wheel at the edge of which a rocker is continually moving backward and forward. The pawls, causing backward and forward movement respectively, are put into action by a lever actuated by the force between two voltmeter solenoids.

Thury System. A system of power transmission and distribution by high tension direct currents, in which all the generators and motors are in series on a single circuit, and the voltage is so regulated that the current in the line is constant whatever the power called for. Individual machines are taken out of circuit by short circuiting them.

Thyratron. A class of discharge tube with hot or cold cathode, usually containing a certain amount of inert gas or vapour, provided with a control grid by means of which the discharge can be stopped or

started as required—used as a relay and for other purposes.

Thyratron Commutator. A thyratron used instead of a commutator to control the current in a motor winding, according to the voltage applied to the control grid.

Thyratron Stroboscope. A special form of thyratron in which a hidden illumination is produced periodically by discharging a condenser across the tube when the grid voltage is allowed to attain a sufficient value. This is done at regular intervals by an arrangement similar to that employed in a *Neon-electric Stroboscope*.

Thyrife. A material resembling porcelain used for lightning arrester resistors, the resistance of which falls considerably above a critical voltage.

Ticker. A vibrating contact maker or interrupter used in early continuous wave wireless telegraph systems to divide up trains of waves so as to make them audible in the receiving telephones. Also spelt *Tikker*.

Tickler Coil. See REACTION COIL.

Tie-Bars. Conductors for connecting together sections into which the bus-bars are divided in a large station. See also BAR COUPLING PANEL.

Tie-Bars, Reactance. See REACTANCE TIE-BARS.

Tie Line (in Telephony). A line connecting two private branch exchanges.

Tie Rod Type of Stator Frame. A form of stator frame for alternators, etc., of large diameter, in which the necessary stiffness is secured without heavy castings by the addition of tie rods of adjustable tension across segments of the frame.

Tie Wire. Wire used to attach a conductor to an insulator. Also called *Binding Wire*.

Tight Coupling. Coupling of two circuits where the *Coupling Factor* is high, e.g. in the case of *Inductive Coupling* where a large proportion of the lines of force pass through both the primary and secondary coils, i.e. where there is little magnetic leakage. Cf. LOOSE COUPLING.

Tikker. See TICKER.

Tilt, Wave. See WAVE TILT.

Time Constant. When the ratio between the rate of change and the value of an increasing or decreasing function is constant it is called the time constant. Thus, in an inductive circuit the time constant is L/R (where L and R are the *Inductance* and *Resistance* respectively), being the time in which a current will rise from zero to 0.623 $[(e-1)/e]$ of its final value under a steady e.m.f. In a Condenser it is the quantity RC (where R is the resistance through which it is discharging and C is the capacitance), being the time in which the current will fall to $1/2.71828$ $[1/e]$ of its original value. The *Thermal Time Constant* of a Machine, etc., is the time it will take to attain 0.623 of its final temperature rise after commencing to run on a steady load.

Time Decrease of Permeability. A gradual reduction in the permeability of a ferromagnetic specimen at low magnetising forces following a temporary increase due to the application of a high magnetising force.

Time Delay Relay. See TIME LIMIT RELAY.

Time Element. The feature in the action of some *Circuit-Breakers* whereby the circuit is not opened instantaneously on the occurrence of an overload, etc., but only after the lapse of a short period; usually depending upon the magnitude of the overload, and roughly inversely proportional to it.

Time Element: Constant, Definite, Independent, and Inverse. See references under TIME LAG.

Time Lag (in Magnetisation). The interval which elapses between the application of a magnetising force and the full attainment of the induction after the screening effect of the eddy currents induced during its rise has ceased.

Time Lag: Constant, Definite, Fixed, Independent, and Inverse. See CONSTANT TIME LAG, DEFINITE TIME LAG, etc.

Time Limit Attachment. A device incorporated in a circuit-breaker, etc., to cause it only to open after

the lapse of a short period from the commencement of the overload, etc. (see **TIME ELEMENT**), e.g. a train of clockwork driving an air vane, a dashpot, a device depending upon the gradual heating of some part, or the adhesion of a disc moistened with a viscous liquid, the winding up of a weight by an induction motor device, or the different rate of growth of a current in non-inductive and inductive circuits. In many cases the time limit device forms a part of a relay actuating the circuit-breaker, instead of being an attachment to the apparatus itself. See **TIME LIMIT RELAY**.

Time Limit Circuit-Breaker. A circuit-breaker fitted with a time limit attachment to give a *Time Element* to its action.

Time Limit Relay. A relay arranged to come into action a short period after the conditions actuating it have begun to exist, the period usually being shorter the more severe are the conditions. Such relays are often used to trip overload circuit-breakers, so as to give a momentary fault time to clear itself without opening the circuit-breaker, while ensuring its sufficiently prompt opening to prevent the overload continuing long enough to cause damage.

Time Meter. See **Hour Meter**.

Time Period. See **PERIOD**.

Time Quadrature. See **QUADRATURE**.

Time Switch. A switch arranged to open or close at a predetermined time by the action of a clock; for controlling lighting, etc.

Timed Spark System (of Wireless Transmission). A method of producing continuous waves from spark discharge apparatus by utilising a number of spark circuits caused to discharge in succession by a *Rotary Disc Discharger* run accurately at such a speed that the short trains of damped oscillations from each discharge are in phase, and maintain, when superposed, a series of practically continuous oscillations. See also **TRIODE SPARK**.

Timed Spark Transmitter. See **TIMED SPARK SYSTEM**.

Tinios Furnace. See **BURIED HEARTH FURNACE**.

Tinned Conductor. A copper or other wire with a thin coating of tin, either to avoid chemical effect on vulcanised rubber insulation or to facilitate soldering.

Tinsel Cord. A very flexible cord for telephone instruments, in which the strands are strips of thin metal foil or tinsel instead of wire. Less liable to break when kinked than ordinary flexible cord.

Tip (of a Telephone Plug). The rounded point of a telephone plug forming the projecting end of the central portion. Cf. **SLEEVE**.

Tip: Arcing and Pole. See **AROUND TIP** and **POLE TIP**.

Tip-Wire (in Telephony). See "**T**" **WIRE**.

Tirrill Regulator. A form of automatic *Voltage Regulator* in which a vibrating contact maker, controlled by relays according to the voltage to be regulated, short-circuits the shunt rheostat intermittently to a variable extent, to give the required regulating effect instead of varying the amount of resistance.

Titanium Carbide Arc-Lamp. An arc-lamp of high luminous efficiency with an upper electrode of carbon and a lower electrode consisting of an iron tube packed with titanium carbide, somewhat similar to the *Magnetite Arc Lamp*.

Toaster (Electric). An apparatus for making toast by exposing slices of bread to a grid of wires heated to incandescence electrically.

Toe (of a Brush). Properly the *Entering Edge*, but sometimes used for the *Leaving Edge*.

Toepler or Toepler-Holtz Machine. An early form of *Influence Machine* with a fixed plate carrying two field plates and a rotating disc, and fitted with several carriers, two sets of brushes, and the usual collector. Also known as *Voss Machine*. Cf. **HOLTZ MACHINE**.

Toll Line. A term used in America for a long distance interexchange telephone line for conversation over which an extra charge is made. Such lines in England are more commonly called *Trunk Lines*;

the term "toll line" being limited to shorter lines of this nature.

Tone. An audible note produced in a telephone receiver by including an intermittent E.M.F. in the circuit in question for signalling purposes, etc.

Tone: Dialling, Ringing, and Side. See DIALLING TONE, RINGING TONE, etc.

Tone Compensated Volume Control. *Volume Control* combined with *Tone Control* to prevent undue weakening of the bass at low volume levels.

Tone Control. The adjustment of the properties of a loud speaker circuit to alter the degree of response over different parts of the frequency range to emphasise the proportion of treble and bass at will.

Tone-Frequency Telegraph System. See VOICE-FREQUENCY TELEGRAPH SYSTEM.

Tone Generator. An apparatus for obtaining an audio-frequency intermittent or alternating current, for producing an audible note in a telephone receiver for signalling purposes or for testing audio-frequency apparatus generally.

Tone Source. See TONE GENERATOR.

Tone Wheel. An apparatus for the reception of continuous waves in wireless telegraphy, consisting of a wheel with fine teeth, separated by insulating material, against which a contact brush presses. When revolved, the apparatus serves as a high speed interrupter. Can be used in a receiving telephone and run at such a speed that the frequency of the interruptions is slightly different from that of the incoming waves, resulting in *Beats* which produce an audible result in the receiver in a similar manner to *Heterodyne Reception*, or as a rectifier.

Tong Test Instruments. See SPLIT ELECTROMAGNETIC INSTRUMENTS.

Tongs, Discharging and Fuse. See DISCHARGING TONGS and FUSE TONGS.

Tonic Train. *Modulated Key-Controlled Continuous Waves* in which

the modulation is approximately sinusoidal.

Tooth. The projecting iron portion of the core plates of an armature, etc., remaining after the slots for the reception of the winding have been punched out. See references under **TEETH**.

Tooth Ratio. The ratio of the width of the *Slot* to that of the *Tooth* in an armature, etc., usually as measured at the circumference.

Tooth Ripples. Small variation in flux caused by the variation in reluctance of the magnetic circuit of a machine, as the successive slots and teeth pass under the poles. Cf. **COMMUTATOR RIPPLES**.

Tooth Top Leakage. See DIFFERENTIAL LEAKAGE.

Top-Contact Rail. The usual type of *Contact Rail* for electric railways, in which the shoe on the train makes contact with the top of the rail. Cf. **SIDE-CONTACT RAIL** and **UNDER-CONTACT RAIL**.

Topping Up. A popular term for filling up accumulator cells with distilled water to make up for evaporation. The addition of acid is not required except at rare intervals, as it does not evaporate.

Torch (electric). A self-contained electric hand lamp complete with dry (or other) battery, usually of cylindrical shape.

Toroid. A coil in which the turns lie upon the surface of a ring of circular section, i.e. a *Solenoid* bent up into a closed ring. Telephone transformers or repeating coils are sometimes spoken of as "Toroidal" when wound on a ring-shaped core without magnetic poles. (In geometry, a "toroid" is a surface formed by the rotation of any plane figure about an axis in its own plane.)

Toroidal (Armature) Winding. See **RING WINDING**.

Torpedo. (1) The *Rain Torpedo* or electric *Ray*, an animal capable of giving electric discharges physiologically. (2) An apparatus containing an explosive charge for the destruction of enemy ships. Some of the earlier forms of self-propelled torpedo, e.g. the *Simms-Edison*

- Torpedo, were electrically propelled, and others are controlled electrically by *Wireless* or otherwise.
- Torque** : **Magnetic, Pull-Out, Starting, and Synchronising.** See **MAGNETIC TORQUE, PULL-OUT TORQUE, etc.**
- Torque Meter.** An instrument, electrical or otherwise, for measuring the torque between portions of rotating machinery.
- Torque Motor.** A motor not intended to rotate but employed to exert a torque over a small range of angular movement of the rotor, e.g. for working crane-brakes, etc.
- Torque-Speed Characteristic.** See **SPEED-TORQUE CHARACTERISTIC.**
- Torsiometer.** An instrument for determining the power transmitted through a shaft by measuring its angular deflection. In one electrical form of torsiometer, pole pieces carried on sleeves attached to the ends of the portion of the shaft under observation move relatively to each other as the shaft twists, causing a variation of the air gap between parts of a magnetic circuit on them, which affects the e.m.f. induced in a winding on one by a current in a winding on the other.
- Torsion Balance.** An instrument used in the early days of electrical theory for studying the laws of electrical attraction and repulsion, in which the force between a fixed charged body and a suspended system capable of angular movement was measured by the degree to which the suspension wire had to be twisted by rotating the head to which it was attached, to bring the moving system back to its original position when neither was charged. A similar apparatus was used for investigation of magnetic attraction and repulsion.
- Torsion Galvanometer.** A galvanometer in which the force between the fixed and moving systems is measured by the angle through which the head to which the suspension is attached has to be rotated to bring the moving system back to its zero position.
- Torsion String Galvanometer.** A very sensitive galvanometer similar to the *Eindhoven String Galvanometer*, but with two fibres in parallel which tend to twist one round the other.
- Total Characteristic.** See **LUMPED CHARACTERISTIC.**
- Total Emission** (in a Thermionic Valve). The maximum thermionic current that can be obtained through a valve.
- Total Equivalent Volt-Amperes.** The total volt-amperes which, at a particular power-factor, would give the same total watts in all the branches of a polyphase system as the actual total load whether balanced or unbalanced.
- Total (Luminous) Flux.** The luminous flux emitted by a light source in all directions. Cf. **UPPER and LOWER HEMISPHERICAL FLUX.**
- Total Losses.** The whole of the energy losses in a machine or apparatus, i.e. the difference between the *Input* and *Output*.
- Total Output Panel.** A panel of a generating station switchboard equipped with meters for measuring the total output of the station.
- Total Reflection Factor.** See **REFLECTION FACTOR.**
- Totally Closed Slots.** See **CLOSED SLOTS.**
- Totally Enclosed Motor.** A motor of the enclosed type with solid covers over the inspection apertures, but not necessarily absolutely gas-tight or water-tight unless specified. Cf. **FLAME PROOF, PIPE VENTILATED, FAN-COOLED, SEPARATELY AIR COOLED, and WATER COOLED MOTORS, and CLOSED CIRCUIT COOLING.**
- Totally Enclosed Switchgear.** Switchgear enclosed in covers without ventilation apertures but not necessarily absolutely gas-tight.
- Touch** : **Divided, Double, and Single.** See **DIVIDED TOUCH, DOUBLE TOUCH, etc.**
- Tough Rubber Sheathing.** Protective sheathing for flexible cables composed of tough vulcanised rubber of a quality resisting mechanical and chemical change.
- Tower.** A support for overhead lines, aërials, etc., of large size. Usually limited to lattice steel structures with broad bases not requiring rigging. Cf. **MAST.**

Tower : Anchor, Dead End, Steel, and Transmission. See ANCHOR TOWER, DEAD END TOWER, etc.

Tower Line. A transmission line with long spans supported on steel towers.

Tracer, Curve. See CURVE TRACER.

Track Booster. See NEGATIVE BOOSTER.

Track Brake. A tramcar or other brake, in which a force is exerted mechanically or electromagnetically between the track and a brake shoe acting directly on it. See ELECTROMAGNETIC BRAKE, ELECTROMECHANICAL BRAKE, EDDY CURRENT BRAKE, SLIPPER BRAKE, etc.

Track Circuit. The circuit in automatic railway signalling systems through one running rail and back by the other, normally of high resistance when the section of the track in question is unoccupied, but in which a current of sufficient strength to actuate a signal or relay is caused to flow when a train or vehicle is present, short-circuiting the rails, thereby indicating that the section is not clear.

Track Circuit Signalling. See TRACK CIRCUIT.

Track Rail Bond. A conducting Bond between lengths of track rail used as a return conductor. Cf. CONDUCTOR BOND.

Track Relay. A relay in track circuit automatic signalling which actuates the signals, interlocking gear, etc., relating to a section of the track, according to the variations in the track circuit current due to the presence or absence of vehicles on the track.

Track Return. The track rails on an electric railway bonded for use as earthed return conductors.

Track Switch. A switch controlling the supply of current to a section of contact rail.

Tracker Wires. Wires making mechanical connection between a switch, etc., and operating handles, etc., at some distance from it. See REMOTE CONTROL.

Trackless Trolley System. See TROLLEY OMNIBUS.

Traction (Electric). The propulsion of vehicles of any kind by electrical methods; usually by motors

driving the wheels. The source of current may either be carried on the vehicles, as in electric automobiles, etc., or current may be conveyed to the motors from a fixed station. Cf. HAULAGE.

Traction : Battery, Canal, Direct Current, Monorail, Petrol-electric, Single-Phase, and Three-Phase. See BATTERY TRACTION, CANAL TRACTION, etc.

Traction Battery. A battery of accumulator cells of a light and durable type suitable for electric traction.

Traction Booster. See NEGATIVE BOOSTER.

Traction Circuit. The whole of a circuit for the immediate supply of trainways or railways, including line-feeders, contact lines, or rails, and earth return (if any).

Traction Generator. A generator in a station used entirely for the supply of current for traction purposes.

Traction Lamp. An incandescent lamp with a robust filament for running in groups of several in series off the ordinary traction voltages, for lighting electric trains or tramcars.

Traction Load. That part of the load on a generating station which supplies current for electric traction. Cf. LIGHTING LOAD and POWER LOAD.

Traction Motor. A motor of a type specially designed for electric traction. In the case of a direct continuous current, usually *Series Wound*. Several types of commutator motor suitable for traction are made for single-phase current, and on three-phase circuits induction motors are generally used. Traction motors are usually enclosed and, except in the smaller sizes, with some provision for ventilation.

Traction Permeameter. An instrument for the measurement of the *Permeability* of samples of iron or steel by measuring the force between the flat end of the bar-shaped sample and a surface forming part of the yoke, by means of a spring balance; while the bar is subjected to a known field by a current in a solenoid surrounding it. Also known as the *Thompson Permeameter*.

Tractive Force. Of a Magnet : The force required to detach an armature from its poles; also called *Tractive Power*.

Tractive Power. See **TRACTION FORCE** (1).

Tractor. A power-propelled vehicle for drawing other vehicles, etc., running either on rails or not. (The term *Locomotive* is usually restricted to tractors running on rails which draw other vehicles, also running on rails.)

Tractor, Canal. See **CANAL TRACTION**.

Traffic Distributor. An automatic switching apparatus used in some telephone exchanges to direct incoming calls to free operators, or when all are occupied, to those with a minimum number of calls in hand.

Traffic Signalling: Automatic and Electromatic. See **AUTOMATIC TRAFFIC SIGNALLING** and **ELECTROMATIC TRAFFIC SIGNALLING**.

Trailer, Control and Driving. See **CONTROL TRAILER** and **DRIVING TRAILER**.

Trailing Brush Holder. A *Box-type Brush Holder* in which the brushes are inclined so that they point in the direction of motion of the commutator.

Trailing Cable. A flexible cable for the supply of current to a portable piece of apparatus, e.g. a coal cutter in a mine, or to a moving object, like the car of a lift.

Trailing Edge (of a Brush). See **LEAVING EDGE**.

Trailing Pole Horn, or Tip. The edge of a field pole which is reached last by an armature conductor in a machine of constant direction of rotation. Cf. **LEADING POLE HORN**.

Train (Electric). A number of vehicles running on rails coupled together, one or more of which is fitted with motors. See **LOCOMOTIVE**, **MULTIPLE UNIT CONTROL**, **MOTOR-COACH**, etc.

Train: Tonic and Wave. See **TONIC TRAIN** and **WAVE TRAIN**.

Train Control. (1) The actual method by which the movements of the controller handle cause the requisite changes in the current supply

to the motors throughout the train. See **MULTIPLE UNIT CONTROL**, **CONTACTOR**, **MASTER CONTROLLER**, etc. (2) The control, to some extent, of the movements of a train in accordance with the signals. See **AUTOMATIC TRAIN STOP**, etc.

Train Descriptor, or Destination Indicator. A semi-automatically controlled apparatus for giving information as to the destination of the next and following trains.

Train Lighting (Electric). Interior lighting of steam trains by incandescent lamps supplied with current from: (1) An independent power-driven generator on the train. (2) Accumulators charged at fixed stations. (3) Accumulators in conjunction with special axle-driven generators arranged to give a practically constant voltage over a large range of speed, and automatic switches to disconnect them when the speed falls below a certain minimum.

Train Lighting Dynamo. See **TRAIN LIGHTING** (3).

Train Line. A circuit, including couplings between coaches, running the whole length of an electric train.

Train Stop, Automatic. See **AUTOMATIC TRAIN STOP**.

Tramcar Meter. An integrating meter mounted on a tramcar for registering the total amount of energy used by that car.

Tramway (Electric). A system where electrically driven passenger cars run on rails laid for the most part along ordinary roads.

Tramway Motor. A motor for the propulsion of tramcars; usually of the series wound fully-enclosed type, driving the axle through single reduction spur gearing and mounted on the truck so that a portion of the weight is spring borne.

Tramway Poles. Poles of steel tube, wood, etc., for supporting the overhead contact line or "Trolley Wire" of an electric tramway. See **SIDE-POLE SUSPENSION**, **CENTRE-POLE SUSPENSION**, **BRACKET-ARM SUSPENSION**, etc.

Transconductance. See **MUTUAL A.C. CONDUCTANCE**.

Transducer. An unsymmetrical artificial line used for coupling together sections of telephone lines of different characteristics to avoid reflection phenomena, for coupling a wireless transmitter to an aerial in a way avoiding distortion and suppressing harmonics, and for all similar purposes.

Transfer Circuit. A circuit between two operators' positions in the same exchange.

Transformation, Phase. See PHASE TRANSFORMER.

Transformation Ratio. See RATIO OF TRANSFORMATION.

Transformer. An apparatus for receiving power from one circuit and delivering it to another, usually with a change in voltage. Generally confined to apparatus without rotating parts, consisting essentially of a laminated iron core provided with a primary winding receiving the supply, and a secondary winding of a different number of turns in which an e.m.f. is induced, having a correspondingly higher or lower voltage.

Transformer : Adapter, Air-Blast, Air-Cooled, Air-Core, Auto-, Automatic Variable Voltage Ratio, Balancer, Bell, Booster, Buffer, Bus-Bar, Bushing, Cable, Capacitor, Closed-Core, Compensator, Constant Current, Core-Type, Current, Direct Current, Electro-kinetic, Electrostatic, Filament Heating, Hedgehog, High Frequency, House, Intertaire, Input, Instrument, Intervalve, Isolating, Motor, Moving-Coil, Neutralising, Non-resonating, Oil, Oil Cooled, One-to-One, Open Core, Oscillation, Output, Phase, Phase Shifting, Pole Type, Potential, Pressure, Rotary, Series, Shell-Type, Single-Lamp, Single-Phase, Single-Turn, Starting, Static, Stationary, Step-Down, Step-Up, Sucking, Summator, Synchronising, Teaser, Telephone, Tesla, Testing, Three-Phase, Three-Wire, Variable Ratio, Variable Voltage, Voltage, Water-cooled, Welding, and "X" Ray. See ADAPTER TRANSFORMER, AIR-BLAST TRANSFORMER, etc.

Transformer Core. The laminated iron magnetic circuit of a transformer built up of stampings less

than half a millimetre thick, of a material which should combine low hysteresis, high specific resistance (to minimise eddy currents), and non-ageing quality. See CORE TYPE and SHELL TYPE TRANSFORMERS.

Transformer Generator. A form of *Frequency Changer* used in some systems of electric propulsion of Ships, constructed like an *Induction Motor* and driven from the same shaft as the main alternator, in which current at one frequency is put into the stator, and current at another frequency, depending on the number of effective poles of the stator winding, is taken from the slip rings.

Transformer Oil. Oil of a quality suitable for use in transformers where the windings are immersed in oil which should combine high dielectric strength, high insulation resistance, absence of moisture, high flash point, and freedom from liability to chemical change due to oxidation or contact with copper causing deposit of "sludge."

Transformer Plate. Sheet iron or steel suitable for construction of *Transformer Cores*.

Transformer Stampings. Stampings of sheet iron or steel for assembly into *Transformer Cores*.

Transformer Switch. A switch, automatic or otherwise, for disconnecting a transformer from its supply circuit at times when it is not being called upon to deal with a load in order to save *Iron Losses*. See also SERIES TRANSFORMER SYSTEM.

Transformer Tank. A tank of cast iron or sheet steel to contain an oil immersed transformer, often with special provision for cooling, such as a ribbed or corrugated surface, external pipes forming a radiator through which the oil circulates, or internal coils of pipes for the circulation of cooling water.

Transforming Station. A station where current is received at one pressure and delivered at another, e.g. in connection with the linking up of transmission lines at different pressures, or to connect a source

of supply with high tension transmission line. A "transforming station" where the current from a high tension line is lowered in pressure for distribution is more usually called a *Substation*.

Transfuse Protective System. A protective system in which fuses in parallel with the relays in conjunction with choking coils give a discriminating time element.

Transient Currents. Rapidly changing currents in a circuit, due to temporary causes such as *Surges*.

Transient Distortion. The alteration in form of a telegraphed signal impulse in transmission due to the influence of the characteristics of the circuit on the building up conditions.

Transient Effect (in Telephony). A form of phase distortion occurring in very long lines in which the high-frequency components arrive later than those of low frequency.

Transient Protective Device. See OVER-VOLTAGE PROTECTIVE DEVICE.

Transient Voltages. See SURGE.

Transition, Bridge and Short-Circuit. See BRIDGE TRANSITION and SHORT CIRCUIT TRANSITION.

Transition Stops. Intermediate arrangement of connections in a traction controller which are passed through between the main stops in order to avoid breaking the circuit, as in the *Bridge* method of passing from *Series* to *Parallel*.

Translating Relay. A telegraph *Relay* which also acts as a *Translator*.

Translator. (1) A telegraph *Repeater*. (2) An instrument which receives messages according to one method of working and passes them on to another line according to another method of working, e.g. from *Wheatstone Automatic* to mirror or syphon recorder (see CREED TRANSLATOR), or from *Single Current* to *Double Current*. (3) A four-winding auto-transformer forming a connecting link between a four-wire three-phase system and single phase lighting distribution.

Translator, Creed and Register. See CREED TRANSLATOR and REGISTER TRANSLATOR.

Translay Protective System. A feeder protective system for three-phase systems employing two pilot wires with relays of the opposed voltage induction type, compensated for capacitance of the pilot wires and energised by current transformers.

Transmission. A term employed to signify the despatch of signals, etc., electrically, in connection with line or wireless telegraphy, telephony, etc., and in connection with heavier currents to signify their conveyance over long distances from one area to another, as compared to distribution in one area.

Transmission : Automatic, Coefficient of, Curb, Double, Petrol-Electric, Radio-, and Thomas. See AUTOMATIC TRANSMISSION, CO-EFFICIENT OF TRANSMISSION, etc.

Transmission Equivalent. The number of miles of *Standard Cable*, to which a telephone circuit is equivalent.

Transmission Factor. The ratio of the *Luminous Flux* passing through a body of more or less transparent nature to the flux incident thereon. Symbol: τ .

Transmission Gear (Electric). Apparatus for the transmission of power electrically, forming the equivalent of mechanical gear of fixed or variable speed ratio, as employed, for example, in *Petrol-Electric Traction* systems and electrical *Ship Propulsion*.

Transmission Level (in a Telephone Circuit). The ratio of the power at any point to the transmitted power in a standard reference circuit expressed in *decibels* or *neper*s.

Transmission Line. One or more circuits for the transmission of current for power purposes, etc., over a long distance, usually at a high voltage, consisting of wires or cables supported on poles, steel towers, etc., across country.

Transmission Towers. Steel frame towers for *Transmission Lines*.

Transmission Unit (T.U.). A logarithmic unit introduced in America to supersede the *Standard Cable* system of telephone transmission constants, such that the two amounts of power transmitted by two circuits under like conditions

differ by n units when they are in the ratio of $1 : 10^{n/10}$. More recently a unit of ten times the value of the T.U. has been introduced, called the *Bel*, so that the T.U. is now known as the *Decibel*. The decibel is equivalent to 9.221 miles of standard cable.

Transmitter. An apparatus for the sending out of telephone or other electrically transmitted messages, signals, etc. Used in line telephony for the actual apparatus, usually of the *Microphone* type, which receives the sound waves of the voice and produces modulations in the amplitude of the current; but in wireless telegraphy and telephony, usually including the whole apparatus for generating the waves.

Transmitter: Arc, Blake, Carbon, Condenser, Controlled, Directive, Eddy-Current, Ionic, Microphone, Multitone, Plain Aerial, Portable, Radio-, Self-Oscillating, Spark, Telegraph, Telephone, Television, Timed Spark, Unidirectional, and Wireless. See ARC TRANSMITTER, BLAKE TRANSMITTER, etc.

Transmitting Circuit. The apparatus and connections of the equipment of a wireless telegraph or telephone station, used exclusively for transmission of messages. Cf. RECEIVING CIRCUIT.

Transmitting Earth (in a Submarine Cable). A Sea-Earth used for transmitting purposes usually a short distance out to sea.

Transmitting Relay. A relay in a reporter equipment which performs the actual re-transmission of the message, as distinguished from the *Auto-Relays* which control the *Auto-Switch*.

Transmitting Station. A station from which wireless or other telegraph messages are sent out. Cf. RECEIVING STATION (2).

Transmitting Valve. A *Thermionic Valve* for use as an oscillator for the production of wireless waves.

Transport Numbers. The ratios of the current in an electrolyte due to the migration of the positive or negative ions respectively to the total current.

Transport Ratio. See MIGRATION CONSTANT.

Transporter (Electric). A form of electric crane in which the load is suspended from a carriage running along an overhead beam, the position of which can be adjusted.

Transposed Conductor. A conductor composed of several bars or strands in parallel for the windings of large generators, etc., arranged so that the relative positions of the respective portions change at intervals and each occupies all positions in the spot in succession. This is done to lessen eddy-currents. Cf. TWISTED CONDUCTORS.

Transposed Winding. A winding composed of TRANSPOSED CONDUCTORS.

Transposing, or Transposition. Changing the relative position of conductors on a line of poles at intervals, to neutralise the mutual inductive effects between neighbouring circuits. Practised both in high tension transmission lines and telephone lines. See TWIST SYSTEM and AMERICAN SYSTEM. See also TRANSPOSED CONDUCTOR.

Transposition Insulator. A special type of insulator for use at points on an overhead line where the conductors are transposed.

Transrector. A combined transformer and rectifier.

Transverse Voltage. A term used in connection with *Interference* in communication circuits for voltages induced between two conductors of the same circuit.

Transverter. An apparatus for converting from alternating current to high tension direct current, and vice versa, consisting of a group of phase-multiplying transformers and a synchronously driven brush system moving within rings of fixed commutator segments.

Trantonium. An electrical musical instrument employing audio-frequency currents from a Neon tube oscillator.

Travelling Substation. See PORTABLE SUBSTATION.

Travelling Waves. A term sometimes applied to voltage surges passing along a transmission line, etc. Cf. STATIONARY WAVES.

Treadle. An apparatus for closing a contact for signalling purposes when a train passes over a particular point on a track.

Treating (of Incandescent Lamps, etc.). See FLASHING.

Tree System of Wiring. A system of interior wiring now superseded by the *Distribution Board* system, in which single branch circuits were taken off from the principal pair of conductors and further branches were taken from these wherever convenient, and so on, like the branches of a tree, and fuses were inserted at all points where a branch was taken off instead of every subcircuit being taken from a distributing board.

Treising (of Accumulator Cells). The growth of a spongy lead deposit on the negative plates of accumulator cells. See LEAD TREE.

Trega-. A prefix meaning 10^{12} times, i.e. a trillion times according to French and American nomenclature, or a billion times according to English nomenclature. Cf. MEGA and BEGA.

Tregohm. A million Megohms, i.e. 10^{12} ohms. Cf. BEGOHM.

Trembler. A springy blade normally lying in contact with a fixed contact point, from which it is drawn away by an electromagnet as soon as the current starts, breaking the circuit. The blade then springs forward and re-makes the circuit, and the same action occurs over and over again, so that an intermittent current is produced of a frequency corresponding to the time of vibration of the blade.

Trembler Bell. An electric Bell, the hammer of which is actuated by a Trembler, so that it keeps up a succession of strokes as long as the c.m.f. is applied to it. Cf. SINGLE STROKE BELL.

Trembler Coil. An *Induction Coil* in which the current is made and broken rapidly in the primary circuit by a Trembler actuated by the magnetic flux in the core of the coil. A condenser is usually connected across the trembler contact, to suppress sparking.

Tribo-Electricity. A term sometimes used for *Frictional Electricity*.

Trichinus. A fish found in the Indian seas capable of producing electrical discharges physiologically.

Trickle Charger. An arrangement by which an accumulator for wireless or other purposes is kept connected through a high resistance to a source of supply so that when not in use it is continually receiving a gradual charge at a very low rate.

Trifurcating Box. A cable *Dividing Box* for making joints between three single-core cables and the three respective cores of a *Three-Core* or *Triple Concentric Cable*.

Trigger Relay. A relay which, once it has been in operation, does not return to its previous condition until reset.

Trigger Spark. A small spark made to pass across a gap to break down its resistance so as to enable a larger spark to pass.

Trillohm. A name sometimes used for 10^{18} ohms.

Trimmer. A small auxiliary condenser for fine adjustment of one or two or more ganged condensers.

Triode. A *Thermionic Valve* with three electrodes, viz., the *Filament* or *Cathode*, the *Plate* or *Anode*, and the *Grid*; and consequently four terminals. Cf. DIODE.

Triode Multiplex. See MORSE MULTIPLEX SYSTEMS.

Triode-Pentode. A thermionic valve consisting of a triode for use as an oscillator and a variable-mu mixing valve in one envelope with a common cathode but separate anodes to each system.

Triograph. An *Electrocardiograph* employing a *Cathode Ray Oscillograph*.

Trip. See TRIPPING DEVICE.

Trip: Bimetallic, Direct, Free, and Independent.

Trip Circuit. The circuit including the winding of the electromagnetic mechanism which trips a circuit-breaker, etc.

Trip Coil. A coil actuating a *Direct Trip*.

Trip Relay. A relay which controls the *Trip Circuit* of a circuit-

breaker, etc., in a protective system.

Trip Switch. A switch for closing the tripping circuit of a circuit-breaker, etc., for actuating it by hand.

Triphase. See **THREE-PHASE**.

Triple-Concentric Cable. A cable in which there are three conductors, consisting of concentric layers of strands with layers of insulation between and over them. Often used for three-wire distribution, as the neutral conductor can easily be made of smaller section than the others. Cf. **THREE-CORE CABLE**.

Triple-Frequency Harmonic. A superposed sine wave, three times the frequency of the fundamental, on the wave form of an alternating current or voltage. Owing to the variation of permeability at different inductions, and to hysteresis effects, there is a somewhat pronounced triple-frequency harmonic component in the magnetising current of a transformer. This is liable to produce circulating currents in the closed circuits of *Delta* connected windings of three-phase transformers, or in *Star* connected windings through the neutral fourth wire (if any). Similarly, triple-frequency currents are liable to circulate through the neutrals of a number of star connected alternators running in parallel with all their neutral points earthed. For this reason, it is usual either only to earth the neutral of one machine at a time, or to earth them all through separate resistances. See **THIRD HARMONIC**.

Triple-Pole Circuit-Breaker, Switch, etc. See **THREE-POLE SWITCH, etc.**

Tripler, Frequency. See **STATIC FREQUENCY CHANGER**.

Triplex (Telegraph) System. A system in which two messages in one direction and one in the other can be sent simultaneously over a single circuit.

Triplex Winding. See **MULTIPLEX WINDING**.

Tripping Device. A mechanically or electrically actuated device by means of which a circuit-breaker or starter is caused to come into the off position either when certain

electrical conditions are realised or by the release of a catch by hand or by mechanical movements. See also **RELEASE**.

Trivector. A meter for integrating kVA.-hours or apparent energy, consisting of power energy and reactive energy integrating mechanisms suitably geared to a third kVA.-hour spindle.

Trolley. A form of current collector for taking current from an overhead contact line or *Trolley Wire* to an electric tramcar or railway vehicle, consisting of a small grooved wheel mounted at the end of a pole hinged at its lower end and provided with springs, so that the *Trolley Wheel* presses upward on the under side of the wire. The original form of trolley collector was a little wheeled truck running on the wire and towed by a flexible cable.

Trolley: Double, Side Running, Single, Trackless, and Under-Running. See **DOUBLE TROLLEY, SIDE RUNNING TROLLEY, etc.**

Trolley Base. A fitting fixed to the roof of a tramcar, carrying a frame pivoted on a vertical axis to which is attached the pivoted trolley pole and the springs which press it upward.

Trolley Boom. See **TROLLEY POLE**.

Trolley Bus. See **TROLLEY OMNIBUS**.

Trolley Bush. A tube of anti-friction metal or graphite in the centre of a trolley wheel, through which the steel axis pin passes and through which the current is taken from the wheel to the axis.

Trolley Car. An expression used, more particularly in America, for a tramcar taking current from an overhead contact line.

Trolley Harp. The metal fork at the end of the trolley pole which carries the axis pin of the trolley wheel.

Trolley Head. The whole fitting at the end of the trolley pole, including the wheel, harp, etc.

Trolley Head: Swivelling. See **SWIVELLING TROLLEY HEAD**.

Trolley Line. The overhead contact line in electric tramways.

Trolley Omnibus. A public service passenger vehicle on ordinary

roads; with steering gear of the usual type, driven by electric motors which derive their current from overhead contact lines. Owing to the impossibility of using an earth return, two trolleys or a double collector, and two overhead lines are required. Also called *Trackless Trolley* system and *Railless Traction* system.

Trolley Pole. The tapered steel tube upon which the *Trolley Head* is mounted; usually insulated from the trolley head and with a separate cable for conveyance of the current.

Trolley Retriever. An arrangement for lowering the *Trolley* clear of the overhead construction if it should jump off the wire.

Trolley Reverser. See AUTOMATIC TROLLEY REVERSER.

Trolley Shoe. A collecting shoe sometimes used instead of a wheel at the end of a trolley pole.

Trolley Standard. A short iron upright, attached to the roof of a tramcar, from the top end of which the trolley pole is pivoted; used on double decked cars without top covers.

Trolley System. The system of electric tramways in which current is collected from an overhead contact line or lines.

Trolley Wheel. The grooved wheel in a trolley collector, usually of gun metal, which actually makes contact with the overhead contact line; sometimes with the tread of the centre part of the groove renewable.

Trolley Wire. The overhead contact line in tramways, etc., or the kind of wire used for the purpose.

Trolley Wire: Figure Eight and Grooved. See FIGURE EIGHT WIRE and GROOVED WIRE.

Tropical Switch. A branch switch mounted on feet clear of the wall.

Trotter Photometer. A portable form of *Illumination Photometer*, in which the brightness of the comparison screen is varied by tilting it.

Trough, Voltaic. See VOLTAIC TROUGH.

Troughing. See CABLE TROUGHING.

Truck-Type Switchgear. See CARBIAGE TYPE SWITCHGEAR.

True Arc Voltage (in Arc Welding). The sum of the *Arc Stream Voltage* and the cathode and anode drops. Cf. WELDING ARC VOLTAGE.

True Dielectric. A substance such as paraffin, sulphur, etc., containing few, if any, free ions or electrons, and therefore a nearly perfect dielectric in its liquid and solid states. Cf. PSEUDO-DIELECTRIC.

True Ohm. The actual value of the practical unit of resistance, i.e. 10^9 absolute electromagnetic units. In view of the fact that standards of resistance can only be made approximately to this true value, the *International Ohm* has a value of about 1.00052 true ohm.

True Power. See TRUE WATTS.

True Remanence. The total residual flux remaining after the magnetising force is removed, not allowing for such self-demagnetising as may exist.

True Resistance. See OHMIC RESISTANCE.

True Watts. This expression is sometimes used in expressing the power in an alternating current circuit (being equal to the product of the volts, amperes, and power factor) in contradistinction to *Apparent Watts*, or *Volt-Amperes*.

Trunk. (1) See *Trunk Line*. (2) In automatic telephone exchanges, a *Link*. (3) Used in the U.S.A. for a *Junction Line*.

Trunk Circuit. (1) A circuit within an exchange, connected to a *Trunk Line*. (2) Such a circuit including the *Trunk Line*.

Trunk Feeder. A *Feeder* connecting a generating station with a substation or inter-connecting two generating stations or two substations.

Trunk Hunting. An expression used in automatic telephone working for the automatic movement of a contact arm in a selector until it comes to rest on a contact connected to an idle line or selector.

Trunk Line. A telephone circuit connecting two exchanges in different areas, called a *Long Distance Line* in the U.S.A.

Trunk Main. See TRUNK FEEDER.

Trunk Switchboard. A telephone exchange switchboard for making connection to *Trunk Lines*.

Trunk Switching Circuit. The part of a telephone circuit at a *Trunk Exchange* connecting a *Subscriber's Line* or an incoming *Junction Line* to an outgoing *Trunk Line*.

Trunnion Type of Alternator. A type of alternator in which the stator is supported by radial arms from central hubs on each side, mounted on the main bearing brackets, and thus without any separate bed-plates or brackets. The stator can be unlocked and rotated round to bring any part into a convenient position for inspection.

Tube : Ballast, Branly, Braun, Cathode Ray, Commutator, Coolidge, Crookes, Detector, Electron, Electron Discharge, Electron Image, Expulsion, Faraday, Focus, Gas, Gas-Discharge, Geissler, Gundelach, Hard, Hittorf, Insulating, Jackson, Lenard, Lilienfeld, Maxwell, Müller, Neon, Radiator, Röntgen, Shearer, Soft, Thermionic, Vacuum and "X" Ray. See BALLAST TUBE, BRANLY TUBE, etc.

Tube Fuse. A fuse in which the fusible wire is enclosed in a tube of insulating material.

Tube Railway. An underground electric railway in deep level cast-iron lined tunnels of circular section each containing a single track, using special rolling stock with small clearance.

Tubes of Force and Flux. Expressions preferred to *Lines of Force*, in quantitative consideration of magnetic and electric force and flux, and in describing the space enclosed by a collection of "lines" of force, etc., passing through the boundary of a small area normal to their direction.

Tubing: Slip-Joint and Screwed. See SLIP-JOINT TUBING and SCREWED TUBING.

Tubular Electric Heating System. A system of electric heating in which the heat is given out at a low temperature (about 200° F.) from tubes containing resistance elements of nichrome or other wire without any circulating liquid.

Tubular Electromagnet. See IRON-CLAD ELECTROMAGNET.

Tubular Lamp. (1) An incandescent lamp for special purposes, such as for use in lines in trough reflectors, with a bulb in the form of a tube, either with the terminals at the same or at opposite ends. (2) A lamp in which the light is emitted by glowing gases or vapour in a tube, e.g. some forms of *Mercury-Vapour* and *Vacuum-Tube Lamps*.

Tubular Protection. A form of protection for apparatus for collieries similar to that described under *Labyrinth Protection* in which the passage consists of groups of parallel fine tubes.

Tudbury Machine. A form of influence machine working inside a closed vessel and using compressed air as a dielectric, on account of its greater insulating quality and dielectric strength than air at ordinary pressures.

Tumbler Switch. A compact form of quick break, single pole switch actuated by a short lever with a round knob; extensively used as a branch switch in lighting installations.

Tuned Anode Circuit. An *Anode Circuit* of a thermionic valve with the inductance and capacity adjusted to give it a natural period of oscillation or resonance.

Tuned Anode Coupling. A method of coupling high-frequency amplifier valves in which the inductance and a variable condenser in parallel are used to tune one anode circuit and the e.m.f. across them (which is high owing to the high impedance to the frequency in question) is applied through a condenser to the grid of the next valve.

Tuned Circuit. A circuit with inductance and capacity so adjusted that it resonates to a particular frequency.

Tuned Plate Circuit. See TUNED ANODE CIRCUIT.

Tuned Reed Frequency Meter. See VIBRATING REED INSTRUMENTS.

Tuned Reed Rectifier. See VIBRATING REED RECTIFIER.

Tuned Relay. A *Relay* employed in some protective systems provided with mechanical or other resonant

ing arrangements so that it responds only to currents of the normal frequency of the system.

Tuner. Any apparatus for making an adjustment to an *Oscillating Circuit* in wireless telegraphy, etc., to bring it into *Resonance* with another.

Tuner, Multiple. See MULTIPLE TUNER and TWO-CIRCUIT TUNER.

Tungar Rectifier. A rectifier for obtaining unidirectional currents from alternating current circuits acting on the principle of the *Thermionic Valve*, with a heated filament as cathode and a graphite disc as anode in argon at a low pressure.

Tungsten Arc-Lamp. A lamp used where a very small but intense source of light is required, in which an arc is produced between tungsten electrodes in an inert gas. One commercial form is called the *Pointolite Lamp*.

Tungsten Filament. A filament for incandescent lamps made of the metal Tungsten, the fusing point of which is about 1,700° C. The earlier tungsten filaments were made by a squirting process, but they are now universally wire-drawn. In the smaller sizes, they are run in a vacuum but in the larger lamps they are used in a tightly coiled form in inert gas at ordinary pressure. See GAS-FILLED LAMPS. Tungsten filaments are also used in thermionic valves and other tubes requiring an incandescent *Cathode*.

Tungsten Filament Lamp or Tungsten Lamp. An incandescent lamp with a *Tungsten Filament*.

Tuning. The adjustment of the inductance or capacitance (or both) of an oscillating circuit to get the maximum degree of *Resonance* with received waves of a particular wave length and the minimum degree of response to waves of any other length. See SYNTONY.

Tuning: Band Pass, Flat, Permeability, Quiet, Sharp, and Visual. See BAND PASS TUNING, FLAT TUNING, etc.

Tuning Coil. See TUNING INDUCTANCE.

Tuning Condenser. A variable condenser used for tuning an oscil-

lating circuit in wireless telegraphy, etc.

Tuning Curve. See RESONANCE CURVE.

Tuning Errors (in *Wireless Direction Finders*). See LOOP TUNING ERROR and PLAIN TUNING ERROR.

Tuning Fork Drive (in *Wireless Transmitters*). A method of *Independent Drive* for ensuring constancy of wave length in which a high harmonic of the oscillations controlled by the continuous vibration of a tuning fork, selected by filter circuits and strongly amplified determines the frequency of the main oscillator. Cf. CRYSTAL CONTROLLER.

Tuning Inductance. A variable *Inductance* used for tuning an oscillating circuit in wireless telegraphy, etc.

Tuning In. Adjusting the tuning of a wireless receiving circuit to give the maximum response to waves from the station which it is desired to hear.

Tuning Out. Adjusting the tuning of a receiving circuit to give the minimum response to waves from sources which it is not desired to hear.

Tuning Switch. A switch for making adjustments necessary for tuning a wireless receiving circuit.

Tunnel. See CLOSED SLOT.

Tunnel Winding. An armature or *Rotor* winding, etc., in which the conductors are drawn into *Closed Slots* in the core.

Tunnel Wound Armature, Rotor, etc. An armature, rotor, etc., in which the winding is contained in *Closed Slots*.

Turbo-Alternator. An alternator of special design for direct coupling to a steam turbine; usually running at a speed from 1,000 to 3,000 r.p.m.; of the revolving field magnet type, with either a cylindrical field system with distributed winding or salient poles, and, in the larger sizes, fully enclosed with forced ventilation.

Turbo-Converter. A form of turbo-generator for producing direct current, designed to obviate the difficulties in the design of a direct current generator of large

size running at turbine speeds; being virtually a combination of an induction generator and a rotary converter. The rotor of the induction generator is mounted on the turbine shaft, while the overhanging member surrounding it is free to revolve and is connected mechanically to the armature of the rotary converter.

Turbo-Dynamo. A direct current generator of special design for direct coupling to a high speed steam turbine provided with a specially strengthened commutator usually held down by shrink rings, and with *Commutating Poles, Compensating Windings*, or both, to minimise sparking. Such machines can only be made satisfactorily in comparatively small sizes.

Turbo-Electric Locomotive. A locomotive for large powers and high speeds, on steam railways, in which the axles are driven by electric motors supplied with current from a steam turbine carried, complete with boiler, condensing plant, etc., on the locomotive.

Turbo-Electric System of Electric Winding. A modification of the *Ignier System* in which the flywheel set is normally driven through gearing by a steam turbine. Its shaft also carries an induction motor which can drive it from the main supply when the local turbine is not under steam, or can act as a regenerative brake when more power is being returned than can be absorbed in the flywheel.

Turbo-Generator. A generator of special design for direct coupling to a steam turbine (see **TURBO-ALTERNATOR** and **TURBO-DYNAMO**), or the whole set consisting of turbine and generator.

Turbo-Generator, Geared. See **GEARED TURBO-GENERATOR**.

Turbulator. A form of *Explosion Pot* for circuit-breakers with transverse openings for the escape of the gases.

Turnbull-McLeod Booster. See **LANCASHIRE BOOSTER**.

Turns, Demagnetising. See **DEMAGNETISING TURNS**.

Turns Ratio (of a Transformer). The ratio of the number of turns per

phase composing the High Tension winding to those of the Low Tension winding.

Turn-Switch. A branch switch actuated by a handle rotated in one direction to open and in the other to close the switch. Cf. **ROTARY SWITCH**.

Twin Cable. (1) A cable, flexible or otherwise, containing two separately insulated conductors not arranged concentrically. (2) In Telephony, a cable with a number of pairs of conductors each twisted together separately.

Twin Cable, Multiple. See **MULTIPLE TWIN CABLE**.

Twin Carbon Arc Lamp. An arc lamp with two pairs of carbons arranged so that the second pair comes into use when the first has burnt away. See also **MAGAZINE ARC-LAMP**.

Twin Concentric Cable. A term now applied to a cable containing a central core with two conductors not concentrically arranged, surrounded by the strands of a third conductor, but sometimes used to mean a two-conductor concentric cable.

Twin Conductor and Twin Flexible Cable. See **TWIN CABLE**.

Twin Flexible Cord. A light type of twin flexible cable each conductor of which is composed of a large number of fine strands, with india-rubber insulation and a further protective covering of cotton or silk, twisted together and covered by a braiding of cotton or silk. Largely used for connections to portable or pendant electric light fittings, etc.

"T" Wire. The wire in a telephone circuit within the exchange, connected to the *Tip* of the plug and to the **"A" Wires** of the line. Cf. **"S" WIRE** and **"R" WIRE**.

Twist System (of Transposition). The older system in which four wires at the corners of a square on each pole form the unit, changing their positions in a right-handed direction at each pole so that a complete rotation is obtained every four spans. Cf. **AMERICAN SYSTEM**.

Twisted Conductors. Conductors for armature bars of large section, etc.,

made up of laminations lightly insulated from one another, and the whole twisted to minimise eddy currents.

Twisted Sleeve Joint. A form of *Mechanical Joint* used particularly for jointing aluminium cables, made by drawing a sleeve over the overlapping ends of the cables to be jointed and twisting the whole.

Twisted Strip Ammeter. An early form of ammeter, due to Ayrton and Perry, in which a soft iron mass, attached to a spring formed by a twisted strip of metal, was attracted by a solenoid, causing the strip to extend and partially to unwind itself, so that a pointer attached to its end gave a magnified indication of the extension by its rotation on a scale.

Twisted Strip Galvanometer. A development, by Duddell, of the *Twisted Strip Ammeter*, in which the extension of the spring and its consequent unwinding is caused by the heating effect of the current to be measured, and a mirror replaces the pointer.

Twisted Winding. A winding for large generators, etc., composed of *Twisted Conductors*.

Two-Band Telephony. See *BI-BAND TELEPHONY*.

Two-Circuit Tuner. An arrangement for tuning simultaneously two tuned and coupled circuits.

Two-Circuit Winding. See *WAVE WINDING*.

Two-Conductor Wiring. Wiring in which two separate conductors, one for each pole, are brought to every point, whether both are insulated or one is earthed. Cf. *SINGLE CONDUCTOR WIRING*.

Two-Core Cable. A cable with two separately insulated conductors alongside each other or twisted together. Cf. *TWIN CONCENTRIC CABLE*.

Two-Electrode Rectification. Rectification by an ordinary three-electrode thermionic valve, using the unilateral conductivity between the filament and the plate, while the grid takes no part in the rectification, although it is given a positive bias to decrease the resist-

ance and to avoid space charge effects.

Two-Electrode Valve. See *DIODE*.

Two-Fluid Cell. See *DOUBLE-FLUID CELL*.

Two-Fluid Theory. The early theory of electrostatics which regarded positive and negative electricity as two separate fluids mutually neutralising each other when present in equal quantities. Cf. *ONE-FLUID THEORY*.

Two-Meter Battery System. A system of measuring the charge and discharge of an accumulator battery employing separate ampere-hour meters connected in series, but each only actuated by a current in one direction. Cf. *ONE-METER BATTERY SYSTEM*.

Two-Part Commutator. A form of commutator now only used on very small machines, with only one armature coil, consisting of two segments formed by dividing a metal tube into two parts, each separately mounted on an insulating cylinder.

Two-Phase. Pertaining to an alternating current system where the circuit is divided into two branches or *Phases*, the currents in which are displaced from each other by 90°.

Two-Phase Alternator. An alternator provided with two armature circuits, so placed that the e.m.f.'s in them differ in phase by 90°.

Two-Phase Currents. Alternating currents flowing in the two branches of a two-phase system displaced from each other by 90°, i.e. by one quarter of a period.

Two-phase Five-Wire System. A system of distribution similar to a *Two-phase Four-Wire System* but with an additional conductor connected to the middle points of both phases.

Two-Phase Four-Wire System. A system of distribution of *Two-Phase Currents* in which two separate conductors are used for each phase.

Two-Phase Generator. See *TWO-PHASE ALTERNATOR*.

Two-Phase Motor. A motor for running on *Two-Phase Currents*, usually of the *Induction* type.

Two-Phase Three-Wire System. A

system of distribution of *Two-Phase Currents* in which one wire is common to both phases.

Two-Phase Winding. A winding divided into two symmetrically arranged circuits, for *Two-Phase Currents*.

Two-Pin Plug. The ordinary form of plug for making connection between a flexible cord and a wall socket, with the contacts for the two poles consisting of projecting pins side by side. Cf. *CONCENTRIC PLUG* and *THREE-PIN PLUG*.

Two-Pole (of machines, etc.). See *BIPOLAR*.

Two-Pole Switch. The equivalent of two *Single-Pole* switches coupled together to open and close a circuit at both poles simultaneously.

Two-Purpose Valve. See *DOUBLE PURPOSE VALVE*.

Two-Range Winding. See *RANGE*.

Two-Rate Meter. A meter provided with two complete movements, or one movement with two different counting trains and sets of dials, put in action during different periods of the day by an automatic time-switch or otherwise.

Two-Stage Current Transformer. A current transformer for wattmeters, etc., provided with an auxiliary high permeability core linked by both primary and secondary windings, and carrying a tertiary winding connected to an additional coil on the wattmeter which has the effect of compensating ratio and phase errors.

Two-Step Relay. A relay with two sets of contacts one actuated by a small current and both by a larger current.

Two-Tier Winding. Another name for *Two-Range Winding*. See *RANGE*.

Two Valve Receiver. See *VALVE RECEIVER*.

Two-Wattmeter Method. A method of measuring the total power in a *Three-Phase System*, whether the load is balanced or not, by adding together the readings of two wattmeters, each with its current coil

in one phase and its voltage coil connected between that phase and the third. The same system can be applied to integrating meters with two movements connected in this manner driving the same shaft, and one brake and counting gear. Cf. *THREE-WATTMETER METHOD*.

Two-Wave Rectification. See *FULL-WAVE RECTIFICATION*.

Two-Way Repeater. A repeater in a telephone line arranged to amplify signals coming from either direction.

Two-Way Switch. A switch in which a single moving contact makes contact with either of two fixed contacts alternatively, used among other purposes for controlling lights from alternative positions.

Two-Wire (Telegraph or Telephone) **Circuit.** A metallic circuit consisting of two separate wires without earth return.

Two-Wire System. A system of distribution for continuous or single phase currents, in which only two conductors are employed, one for the lead and the other for the return. Cf. *THREE-WIRE* and *FIVE-WIRE SYSTEMS*.

Two-Wire Telephone Circuit. A metallic circuit composed of two conductors alongside each other or twisted together.

Type "A" Waves. See *CONTINUOUS WAVES*.

Type "A 1" Waves. See *UNMODULATED KEYED CONTINUOUS WAVES*.

Type "A 2" Waves. See *MODULATED KEYED CONTINUOUS WAVES*.

Type "A 3" Waves. See *SPEECH-MODULATED CONTINUOUS WAVE*.

Type "A 1" Waves. See *SUPER-AUDIOFREQUENCY MODULATED CONTINUOUS WAVES*.

Type "B" Waves. See *DAMPED WAVES*.

Type Printing Telegraph. A system of telegraphy in which the message is automatically printed in type at the receiving station. See *BAUDOT*, *CREED*, *HUGHES*, *MURRAY*, *STELJES* and *TELETYPE SYSTEMS*, and *ZEROGRAPH*.

U]

[Ult

Ulbricht Globe or Sphere Photometer.

An instrument for measuring at one operation the mean spherical candle-power of a light source; consisting of a hollow globe whitened inside, within which the lamp to be tested is placed. The intensity of the illumination on the interior surface of the globe, on account of internal reflection, is proportional to the total amount of light emitted by the source in all directions, and is observed through a small window in the globe.

Ultimate Limit Switch. See FINAL LIMIT SWITCH.**Ultra-Acoustic Teleprinter Working.**

The superposition on a telephone circuit of teleprinter signals of a frequency above the audio-frequency range, e.g. about 2900 cycles per sec.

Ultradyné Reception. A system of wireless reception, similar to the *Superheterodyne* system, in which the intermediate frequency is obtained from auxiliary oscillations superposed upon the plate circuit of the first valve.**Ultra-Gamma Radiation.** See PENETRATING RADIATION.**Ultra-Incandescent Lamp.** An incandescent lamp the efficiency of which is increased by the addition to the filament of a coating of rare oxides, of high selective radiative power.**Ultra-Magnifier.** See RETROACTION CIRCUIT.**Ultra-Micrometer.** An instrument for measuring very small changes in dimensions by the alteration in the distance apart of the electrodes of a condenser and consequent slight change in capacitance.**Ultra-Photic Radiation.** A term sometimes used for ULTRA-VIOLET RAYS.**Ultra-Short Waves.** *Electric Waves*

of lengths from 100 cm. to 10 m. Cf. MICRO WAVES.

Ultradion. A special type of thermionic valve receiving circuit employing *Reaction*.**Ultra-Violet Lamp.** A lamp giving light particularly rich in ultra-violet rays; either a special class of arc lamp (e.g. the *Finsen Lamp*), a special mercury vapour lamp (e.g. the *Quartz*, *Heraeus*, *Uviol*, or *Sunlight Lamps*), or a metal filament lamp in a bulb of special glass transparent to ultra-violet rays.**Ultra-Violet Light Meter.** An instrument for measuring the intensity of that part of the radiation from a source which is of higher frequency than the visible spectrum. In one form the rate of charge of a condenser by a battery through a photoelectric cell screened by a suitable filter and exposed to the radiation in question is recorded by causing a glow tube to start discharging as soon as the voltage is sufficient. A relay is then actuated, which works a counter or other recording mechanism, and the condenser is discharged so that the cycle of operations begins again.**Ultra-Violet Rays.** Radiation of a higher frequency than that which can affect the eye, i.e. beyond the visible violet end of the spectrum. Such rays have powerful actinic effect and have the power of causing *Ionisation*, and can produce phosphorescence and photoelectric effects. They are also employed extensively for curative purposes, and to stimulate plant growth. Their wave length ranges from about 136 to 4,000 Ångström units, of which the range from 2,900 to 3,200 Å. has the greatest physiological effect, and that below 3,200 Å. the greatest

photographic effect. See **ULTRA-VIOLET LAMP**.

Ultra-"X" Rays. Very penetrating rays of even shorter wave length than *Gamma Rays*.

Umbrella Aerial. A form of aerial for wireless transmitting stations in which the component wires radiate from a central pole or tower downwards to the ground.

Umbrella Type Alternator. A vertical shaft alternator for coupling to water turbines, in which an overhung revolving field surrounds the stationary armature.

Unarmoured Cable. A cable, lead covered or otherwise, in which there is no outside protective covering of steel wire or tape. Cf. **ARMoured CABLE**.

Unbalanced Load. A load which is unequal on the two sides of a three-wire system, or in the three branches of a three-phase system, etc.

Unbalanced Magnetic Pull. The transverse magnetic pull on the rotor of a machine when slightly out of centre, due to inequality of air gap; producing a bending moment in the shaft and excessive wear of the bearings, both of which tend to aggravate the cause.

Unbalanced System and Unbalanced Three-Phase System. See **UN-BALANCED LOAD**.

Undamped Oscillations and Waves. *Oscillations or Waves* which continue with undiminished amplitude as long as they last.

Under-Compensated Meter. An *Induction Meter* reading high with a leading current and low with a lagging current, owing to insufficient *Phase Compensation*.

Under-Contact Rail. A conductor rail supported from above so that the collectors can make contact with the underside, while the upper part is well protected from accidental contact. Cf. **TOP AND SIDE CONTACT RAILS**.

Underground Cable. A cable with suitable insulation and protection (lead covering, armouring, etc.) for laying underground, either direct, when steel armouring is usual, on the *Solid System* in troughing with bitumen, or drawn

into *Ducts*. The insulation is usually impregnated paper or jute, or vulcanised bitumen.

Underground Conduit. Some form of tube or channel laid underground for the reception of cables; of earthenware, iron, cement, bitumen composition, etc.

Underload Circuit-Breaker, Relay, Release, etc. See **MINIMUM CIRCUIT-BREAKER, etc.**

Underrunning Rail. See **UNDER CONTACT RAIL**.

Underrunning Trolley. The usual type of trolley which makes contact with the underside of the wire.

Undersaturated Exciter. A small exciter worked on the steep part of its saturation curve, employed to steady the speed of an *Inverted Rotary Converter* by compensating for the field weakening effect of lagging currents in the converter which would tend to increase the speed.

Underslung Monorail Railway. See **SUSPENDED RAILWAY**.

Undertype Dynamo or Generator. A bipolar dynamo in which the armature is situated below the yoke. Cf. **OVERTYPE DYNAMO**.

Under-Voltage Circuit-Breaker, Relay, Release, etc. A *Circuit-Breaker, Relay, etc.*, coming into action when the voltage falls below a predetermined value.

Undulator. (1) A telegraph receiving instrument for use on long lines, consisting of a delicate polarised relay, to the arm of which a syphon pen is attached, making a wavy line record similar to that of a *Siphon Recorder* on a paper strip. This instrument is used in conjunction with the *Gulstad Relay* for cable circuits. (2) An apparatus of the nature of an *Ionic Valve* used for converting d.c. into a.c.

Undulatory Current. See **PULSATING CURRENT**.

Unequal Linkage Leakage (in Induction Motors, etc.). See **DIFFERENTIAL LEAKAGE**.

Unidirectional Aerial. An aerial arranged to send out waves of maximum strength in a particular

direction but nearly zero in the opposite direction. Cf. **DIRECTIONAL AERIAL**.

Unidirectional Current. A current, with or without pulsations, flowing in one direction only.

Unidirectional Receiver. A wireless receiver having maximum sensitivity in a particular direction but practically zero in the opposite direction. Cf. **DIRECTIONAL RECEIVER**.

Unidirectional Transmitter. A wireless transmitter employing a *Unidirectional Aerial*.

Unidyne Reception. A name given to an arrangement of wireless receiving apparatus in which the same battery is used for the filament and anode circuit, and an additional electrode is employed to prevent an excessive space charge.

Unifilar Suspension. Suspension of the moving system in galvanometers, etc., by a single thread, wire, fibre, etc., the torsion of which provides the whole or part of the restoring force. Cf. **BIFILAR SUSPENSION**.

Unilateral Conductivity. Conductivity in one direction only. See **CRYSTAL DETECTOR**, **RECTIFIER**, etc.

Uninsulated Conductor. A conductor which, even if not purposely connected with the earth, has no special precautions taken to secure its insulation from the earth.

Uniphase. See **SINGLE-PHASE**.

Unipivot Instrument. A form of moving coil instrument in which the moving system is balanced on a single pivot at its centre of gravity.

Unipolar Dynamo or Generator. See **HOMOPOLAR GENERATOR**.

Uniselect. A selector in which the moving system has a circular motion and does not move axially to change the level. It may, however, carry wipers on more than one level.

Unit (of Electric Supply). See **BOARD OF TRADE UNIT**.

Unit(s): Absolute, Ångström, Arbitrary, Board of Trade, C.G.S., Derived, Electro-magnetic, Electrostatic, Fundamental, Gaussian, Heaviside, Independent, Practical, Q.E.S., Siemens, and Weber's.

See **ABSOLUTE UNITS**, **ÅNGSTRÖM UNIT**, etc.

Unit Charge (Electrostatic). That charge which, if concentrated at a point, exerts a mechanical repelling force of one dyne on an equal charge of the same sign concentrated at a point one centimetre from it in a vacuum. Symbol: Q . See also **QUANTITY OF ELECTRICITY**.

Unit Electric Flux. The electric flux produced *Unit Charge*.

Unit Feeder. See **SINGLE FEEDER**.

Unit Magnetic Pole. A magnetic pole supposed concentrated at a point which, when placed one centimetre from another pole of equal strength, in a vacuum, repels it with a force equal to one dyne.

Unit Switch. A name sometimes given to one of a series of contactors in a traction controlling equipment, etc.

Unit Tube of (Electrostatic or Electromagnetic) Force. See **FARADAY TUBE** and **MAXWELL TUBE**.

Unitary Ratio. The ratio of the electromagnetic to the electrostatic absolute units, equal to the velocity of light and other electric waves in centimetres per second, i.e. approximately 3×10^{10} .

Universal Battery System. A term applied in telegraphy for the *Central Battery System*.

Universal Controller. A controller for crane work, etc., in which vertical movement of the handle controls the hoisting motor, and horizontal movement the slowing motor, so that the load follows the movements of the handle.

Universal Mains Receiver. A receiver which can be worked on a.c. or d.c. mains without alteration.

Universal Shunt. A galvanometer shunt box arranged so that it can be used with galvanometers of widely differing resistances. The shunt resistance is permanently connected across the terminals of the galvanometer, and the circuit is connected to proportional tapings thereon.

Universal Valves. Thermionic Valves for use in *Universal Mains Receivers*. Usually of the indirectly heated type the heaters of which can be connected in series direct

on the mains with or without a further resistance but without a transformer.

Unloaded Aerial. An aerial with no added inductance or capacitance. See LOADED AERIAL.

Unloaded Wavelength. The wavelength corresponding to the frequency of the free oscillations in an aerial without the addition of inductance or capacitance.

Unmarked Pole. The *South Pole* of a permanent magnet. Cf. MARKED POLE.

Unmodulated, Key Controlled Continuous Waves. Continuous waves broken up for telegraph signalling purposes by a definite change of amplitude or frequency. (Sometimes called *Type A1 Waves*.)

Untuned Aerial. See APERIODIC AERIAL.

Untuned Circuit. See APERIODIC CIRCUIT.

Untuned Secondary Circuit. A detector circuit in a wireless receiving equipment inductively coupled to the aerial circuit, but having no definite period of oscillation of its own.

Upper Hemispherical (Luminous) Flux. The flux emitted by a light source above an horizontal plane

through its centre. Cf. LOWER HEMISPHERICAL FLUX.

Upper Side Band. A *Side Band* composed of frequencies of the sum of the *Carrier* and modulating *Frequencies*. Sometimes eliminated by wave filters, etc., together with the carrier frequency wave, so that only the Lower Side Band is transmitted in order to economise power, to take up a narrower range of frequencies, and for other reasons. When this is done, it is necessary to re-introduce the carrier frequency in the receiving apparatus in order to obtain the correct resultant audio-frequencies for intelligible speech.

Uranium Rays. See BEQUEREL RAYS.

Utilisation Coefficient, Specific. See SPECIFIC UTILISATION COEFFICIENT.

Utilisation Factor. A term used in photometry for the ratio of the luminous flux reaching the working plane from a lamp to the whole flux from that lamp.

Uviol Lamp. A mercury vapour lamp for photographic and medical work, made with a special glass nearly as transparent to ultra-violet rays as quartz. Cf. QUARTZ LAMP.

V]

V. Abbreviation for *Volt*. Symbol for *Potential Difference*.

v. Symbol for the velocity of propagation of light and other electric waves in free space. Approximately 3×10^{10} cm. per second (or 186,000 miles per second); more accurately 2.9982×10^{10} cm. per second.

VA. Abbreviation for *Volt-Ampere*.

Vacuo-Junction. A thermo-couple attached to a fine heating wire in an exhausted bulb, for the measurement of alternating or high frequency current in the latter by a galvanometer connected to the former.

Vacuum Cleaner (Electric). An apparatus for removal of dust from fabrics, etc., with an electrically driven fan or pump for drawing air through a nozzle applied to the article to be cleaned.

Vacuum Impregnation. See **VACUUM OVEN**.

Vacuum (Filament) Lamp. A *Filament Lamp* in which the filament is enclosed in a bulb exhausted to a high vacuum. Cf. **GAS-FILLED LAMP**.

Vacuum Oven. An oven for heating armatures, coils, etc., to a moderate temperature in a vacuum to ensure removal of moisture from the insulation, or to effect the thorough impregnation of fibrous insulating materials with varnishes, etc., by applying them in a vacuum so that when the full air pressure is again applied, the impregnating material is forced into every crevice.

Vacuum Tube. A term formerly applied to all forms of *Discharge Tube*, but properly limited to those in which the vacuum is high enough for the residual gas not to affect the discharge.

Vacuum Tube. Inverted. See **INVERTED VACUUM TUBE**.

Vacuum Switch. An electromagnet-

ically actuated switch with the contacts enclosed in an exhausted bulb.

Vacuum Tube Lamp. See **GAS DISCHARGE LAMP**.

Vacuum Valve. A *Vacuum Tube* having rectifying properties. See **OSCILLATION VALVE**, **LODGE VALVE**, etc.

Vagabond Currents. Leakage currents flowing in the earth from electric supply or traction systems. They are liable to cause electrolytic damage to buried metal pipes, etc.

Valve (Electric). A device which only allows the flow of current in one direction, i.e. a *Rectifier*. The use of the term is generally limited to apparatus without moving parts. In wireless telegraphy, etc., the term valve is commonly used for a thermionic valve, whether used strictly as a rectifier or not. See also **AUTO-CONVERTER**.

Valve: Absorber, Bigrid, Bright Emitter, Buffer, Cold Emitter, Control, Demountable, Double-Purpose, Driver, Dull-Emitter, Electrolytic, Electrometer, Electron, Five-Electrode, Four-Electrode, Giles, Hard, Helium, Indirectly-Heated, Ionic, Lodge, Metallised, Modulating, Multigrad, Nodon, Oscillation, Output, Power, Raytheon, Rectifying, Retardation, Screened, Shielded Grid, Soft, Space-Charge Grid, Super-Power, Thermionic, Three-Electrode, Three-in-One, Transmitting, Two-Electrode, Two-Purpose, Universal, Vacuum, Variable-Mu, and Water-Cooled. See **ABSORBER VALVE**, **BIGRID VALVE**, etc.

Valve Adaptor. An accessory whereby a *Thermionic Valve* with one type of terminal can be used in a holder designed for another type.

Valve Amplifier. See **THERMIONIC AMPLIFIER**.

Valve Base or Cap. The cap on a *Thermionic Valve* which carries the contact pins fitting into the sockets in the holder.

[Val

Valve Counter. An apparatus for detecting single alpha or similar projected particles by the sudden ionisation produced in a special chamber connected through amplifying valves to an oscillograph.

Valve Detector. See THERMIONIC DETECTOR.

Valve Drive. *Independent Drive* in which the frequency of the master oscillator is determined by the natural period of a thermionic valve oscillator. Cf. MECHANICAL DRIVE.

Valve Holder. An appliance for holding and making contact with the terminals of *Thermionic Valves*, usually arranged so that the valve can be inserted only the right way round.

Valve Holder: Anti-Capacitance, Anti-Microphonic, and Anti-Vibration. See ANTI-CAPACITANCE VALVE HOLDER, ANTI-MICROPHONIC VALVE HOLDER, etc.

Valve Noise. Interfering noise heard in wireless receivers, due to causes within the valves themselves.

Valve Oscillator. See THERMIONIC OSCILLATOR.

Valve Receiver. A wireless receiving set employing *Thermionic Valves*, a detector, amplifiers, etc.

Valve Rectifier. See VALVE and RECTIFIER.

Valve Relay. A thermionic valve connected to an oscillator and arranged to act as a *Relay* (not an *Amplifier*) by producing sustained oscillations in the anode circuit as soon as the weak oscillation in the grid circuit reaches a sufficient value to react on it.

Valve Transmitter. A wireless transmitting apparatus employing *Thermionic Valves* as the source of the oscillations.

Valve Voltmeter. See THERMIONIC VOLTMETER.

Valve-operated Induction Furnace. A high-frequency induction furnace in which the supply, at a suitable frequency is derived from a *Thermionic Oscillator*.

Var. Abbreviation for *Volt-amperes Reactive*.

Var. Practical unit of *Reactive Power*, being one reactive volt-ampere.

Var-hour Meter. See REACTIVE VOLT-AMPERE METER.

Variable Condenser. A condenser, the capacity of which can be adjusted by a relative movement of the electrodes or otherwise, e.g. a *Tuning Condenser*.

Variable Coupling. Inductive coupling, the tightness of which can be varied by relative movement of the primary and secondary windings; used in wireless telegraphy to adjust the *Sharpness of the Tuning*, and to control the amount of *Retraction* in regenerative circuits.

Variable Inductance. An inductance, the value of which can be varied, e.g. a *Tuning Inductance*. See also VARIOMETER.

Variable-Mu Valve. A type of *Screened Valve* in which the range of distortionless working is increased by a design such that the anode current-grid voltage characteristic has a long gradual curvature at high negative grid voltages in such valves the amplitude factor can be varied by adjusting the grid bias either manually or automatically according to the signal strength.

Variable Ratio Transformer. A transformer the voltage ratio of which can be varied by means of tappings on the secondary winding or otherwise.

Variable Resistance. See RHEOSTAT.

Variable Speed Motor. A motor the speed of which can be adjusted to any desired value, irrespective of the load, within certain limitations. Cf. VARYING SPEED MOTOR.

Variable Speed Scanning. A method of scanning in cathode-ray television in which the speed of deflection of the scanning beam is governed by the optical density of the object (in this case a film). The beam in the receiver is of constant intensity and copies the motion of the beam in the transmitter owing to inter-connection of the deflecting circuits and as the apparent illumination of the screen depends upon the speed of the beam, the picture is reproduced.

Variable Voltage Control. Control of the speed of a motor, etc., by

variation of the applied voltage, e.g. *Ward Leonard System*.

Variable Voltage Generator. A generator the voltage of which can be varied at will between certain limits, by shunt regulation or otherwise.

Variable Voltage Transformer. See VARIABLE RATIO TRANSFORMER.

Variable Voltage Welding. A system of *Arc Welding* in which the source is arranged to give a reduced voltage as the current increases.

Variation. (1) An expression sometimes used for the maximum deviation, in electrical degrees, from synchronism with a wave of constant frequency in an alternator driven by an engine of unequal turning moment, and sometimes for the angular displacement of the rotor under these conditions in degrees. See also CYCLIC IRREGULARITY. (2) A change in the direction of the *Magnetic Meridian*.

Variation: Annual, Diurnal, and Secular. See ANNUAL VARIATION, DIURNAL VARIATION, etc.

Variation Factor. The ratio of the maximum to the average illumination along a street or over a surface under artificial lighting.

Variation Range. The ratio of maximum to minimum illumination in street lighting, etc.

Vario-Coupler. An apparatus to effect a variable coupling of circuits, usually of similar construction to a *Variometer* but without the coils interconnected.

Variometer. A form of variable inductance for arial circuits, composed of two coils wound in opposite directions, the angular position of which relatively to each other can be varied.

Varley Slide. See THOMSON-VARLEY COILS.

Varley's Loop Test. A method of *Fault Localisation* in which a bridge test is first made of a loop of cable containing the fault, with one pole of the battery earthed, so that the fault forms the corner of the bridge, and then one in the usual way for copper resistance of the loop. Then, if a and b are the values of the *Proportional Coils* (in

both tests) d is the resistance of the variable arm in the first test, c is the copper resistance and l is the length of the loop, the distance of the fault is $l(bc - ad)/(a + b)$.

Varnish, Insulating. See INSULATING VARNISH.

Varnished Cambrie Cable. See VARNISHED CAMBRIC.

Varnished Cambric. Fine cambric impregnated with varnish or special compounds, used for the insulation of cables, and for the construction of tube for insulating slot linings, etc.

Varying Speed Motor. An expression used in America to define a motor in which the speed varies according to the load, e.g. a series wound motor. Cf. VARIABLE SPEED MOTOR.

Vat, Electroplating. See ELECTROPLATING VAT.

"V" Connection. The connection of two phases of a three-phase circuit, with three wires taken from their common junction and free ends, forming the equivalent of a *Delta Connection* with one phase-winding missing.

Velocity, Ionic, and Wave. See IONIC VELOCITY and WAVE VELOCITY.

Velocity of Propagation. The velocity with which an electrical disturbance is radiated as a wave through a medium, e.g. the velocity of light; equal, in the case of a dielectric, to $1/\sqrt{\kappa\mu}$, where κ and μ are the permittivity and permeability of the medium. In the case of waves propagated through wires, such as telephone current in a cable, depending also upon the frequency. See DISTORTION. Equal in free space to 3×10^{10} cm. per second, or about 186,000 miles per second. Symbol: v .

"V" End Connections. "V" shaped connectors connecting the pairs of bars forming the coil sides in bar wound armatures.

Vent Plug (in Accumulator Cells). A form of stopper for enclosed cells which permits of escape of the gases evolved during charging without allowing the acid to splash over.

Ventilated Commutator. A type of

commutator sometimes used in turbo-dynamos which has air channels in the segments for cooling purposes.

Ventilated Motor. A motor with some provision for air circulation for cooling purposes. See ENCLOSED VENTILATED MOTOR, PIPE VENTILATED MOTOR, etc.

Ventilating Duct. A channel through an armature core, etc., for the circulation of air for cooling purposes.

Ventilating Ducts : Axial and Radial. See AXIAL DUCTS and RADIAL DUCTS.

Ventilating Fan. In general, a fan, electrically driven or otherwise, to produce a current of air for ventilating purposes, e.g. a centrifugal fan at the end of the rotor of an enclosed machine to draw cooling air through the case.

Ventilating Plant (Electrical). Electrically driven fans and necessary accessories for producing a current of air for ventilating purposes in buildings, ships, mines, etc.

Ventilation : Forced and Induced. See FORCED VENTILATION and INDUCED VENTILATION.

Verdet's Constant. The coefficient determining the angle of *Magneto-Optical Rotation* of a beam of polarised light produced in a particular material ; being the value of w in the expression for the angle of rotation, $wH \cos \beta l$ (where H , β , and l are the field, the angle between the beam and the lines of force, and the length respectively), positive for diamagnetic substances, and negative for ferromagnetic substances.

Vernier Coils. See THOMSON-VARLEY COILS.

Vernier Condenser. An auxiliary variable condenser for carrying out fine adjustment.

Vernon Harcourt Pentane Lamp. See PENTANE LAMP.

Versatile Galvanometer. Name sometimes given to a galvanometer which can be used either for direct or alternating current.

Versorial Force. See DIRECTIVE FORCE.

Versorium. Name used by Gilbert and the early writers for a pivoted

magnetised needle or a non-metallic pivoted needle used as an electro-scope.

Vertical Carbon Arc-Lamp. An arc-lamp in which both carbons are vertical and in line. Cf. INCLINED CARBON ARC LAMP.

Vertical Component. The component of the force exerted on a unit pole in a vertical plane by the earth's magnetic field at any point on the earth's surface. Cf. HORIZONTAL COMPONENT.

Vertical Current. The small current always passing from the upper atmosphere to the earth, due to *Atmospheric Electricity*.

Vertical Shaft or Vertical Spindle Motor. A motor the armature or rotor of which is mounted on a vertical shaft with the necessary thrust bearing to take its weight, e.g. for direct coupling to a centrifugal pump for mine sinking, to a centrifugal separator, etc.

Verticity. See DIRECTIVE FORCE.

Vertiginous Magnetism. A term used by early writers for magnetism produced by a current.

Very Short Waves. An expression sometimes used for wavelengths below 10 metres (above 30,000 kc.). Also called *Ultra-Short Waves*. Cf. LONG, MEDIUM, INTERMEDIATE, and SHORT WAVES, and MICRO-RAYS.

Vibrating Reed Instruments. Instruments for measuring frequency, etc., consisting of a row of spring tongues or reeds of steel, each with a different and known period of mechanical vibration, in the field of an electromagnet excited by an alternating current. The reed whose natural frequency corresponds most nearly with that of the current vibrates in resonance to the field, and can be clearly distinguished from the others, which remain at rest, and the frequency can be read off on a scale alongside the row of reeds.

Vibrating Reed Rectifier. An apparatus for rectifying an alternating current by periodical reversal by the movement of a vibrating member of magnetic material in a control field produced by a permanent magnet acted upon by a

superposed field produced by the alternating current.

Vibration Damper. See ANTI-VIBRATION DEVICE.

Vibration Galvanometer. A sensitive galvanometer with undamped moving parts for alternating current, in which the moving system vibrates with the alternations, so that the spot of light from a mirror thereon makes a streak on the screen; used for *Zero Methods* only. The sensitivity of such an instrument is a maximum if the period of free swing is adjusted to equal the period of the oscillations.

Vibrator. (1) A vibrating contact-breaker. See TREMBLER. (2) A portable apparatus driven by a small motor for producing mechanical vibrations by a rapidly reciprocating part, for massage, etc. (3) The moving system of an *Oscillograph*. (4) A form of *Phase Advancer* with a reciprocating armature. See KAPP VIBRATOR.

Vibrator, Kapp and Multi. See KAPP VIBRATOR and MULTI-VIBRATOR.

Vibratory Phase Advancer. A *Phase Advancer* with reciprocating moving parts, e.g. the *Kapp Vibrator* and the *Recuperator*. Cf. *Rotary Phase Advancer*.

Vibrograph. An apparatus for recording vibrations of machinery, etc. In one electromagnetic form relative movement between fixed and spring supported portions of the apparatus alters the relative length of the air gaps of two high-frequency transformers in opposition and modulates the resultant output which is amplified and recorded.

Villari Reversal. The reversal, above a particular field strength, of the effect of stress on the permeability of iron, which tends to increase with stress at low fields and to decrease at high fields. (The latter is always the case with nickel, where there is no Villari reversal.)

Vielle Standard. A standard of luminous intensity proposed in Paris by Vielle, in 1881, consisting of the light given off by a square centimetre of molten platinum at the temperature of solidification.

This was the basis from which 'he *Carcel* or *Bougie Decimale*, later adopted as the *International Candle*, was derived, being one-tenth of the value of the Vielle standard.

Virtual Values, Virtual Voltage, etc. See ROOT MEAN SQUARE VALUES.

Viscosity : Dielectric and Magnetic. See DIELECTRIC VISCOSITY and MAGNETIC VISCOSITY.

Viscous Hysteresis. The lagging behind of the attainment of the full value of the intensity of magnetisation after the magnetising force has been applied. Also called *Magnetic Viscosity*. See also MAGNETIC CREEPING.

Visible Radiation. Radiation between the limits of frequency corresponding to the limits of the visible spectrum, i.e. ordinary light. The wavelengths range from 4,000 to 8,000 Ångström Units. Cf. ULTRA-VIOLET RAYS and INFRA-RED RAYS.

Visibility Factor. The ratio of the *Luminous Flux* to the total energy being radiated.

Vision Frequency (in Television). The frequency of any component in the modulation produced by the scanning device in the transmitter.

Vision Frequency Generator. The apparatus in a television transmitter which produces current modulated in accordance with the scanning of the object.

Visual Tuning. Arrangements in a *Wireless Receiver* whereby an indicating strip of light glows when the circuit is accurately tuned to an incoming carrier.

Vita-Rays. A term sometimes used for the range of ultra-violet rays which have a physiological effect.

Vitreous Electricity. An old name for *Positive Electricity* because vitreous bodies, such as glass, become positively charged by friction. Originated by Dufay in 1735. Cf. RESINOUS ELECTRICITY.

Vitrite Cap. An incandescent lamp cap insulated with a non-hydroscopic glassy material known as Vitrite; more suitable for damp climates than the plaster of Paris filling formerly used.

Vodas. A name given to an apparatus consisting of a switch controlled by a valve-relay employed in the case of a wireless link in telephony to connect the subscriber's line automatically to the transmitting station and to disconnect it from the receiving station as soon as he starts speaking; and to perform the reverse operation when he is listening.

Voice Frequency. The frequency range of ordinary speech and singing, i.e. from about 100 to 2,000 cycles per second. Cf. **AUDIO-FREQUENCY**.

Voice Frequency Telegraph System. A system in which several channels are obtainable in one pair of conductors by using a different audio-frequency for each message, derived from tuning fork controlled thermionic oscillators, superposed on the line and selected by suitable filter circuits after amplification at the receiving end; extensively used in the British Post Office up to 18 channels in one circuit.

Volt (V.) The practical unit of *Electromotive Force*, *Potential Difference*, etc., being 10^8 C.G.S. units and that e.m.f. which produces a current of one ampere through a resistance of one ohm. Named after the Italian physicist Alessandro Volta (1745-1829). See **INTERNATIONAL VOLT**.

Volta Effect. The E.M.F. between dissimilar metals in contact.

Voltage. *Electromotive Force* or *Difference of Potential* expressed in Volts.

Voltage: Active, Anode, Applied, Arcing, Arc-Stream, Asymmetrical, Balanced, Bias, Breakdown, Cascading, Ceiling, Critical, Delta, Diametrical, Decomposition, Effective, Equivalent Disturbing, Electrolytic Solution, Excess, Grid, Grid-Priming, Ignition, Impressed, Internal, Line, Longitudinal, Lumped, Mesh, Needle-Point, Normal, Over, Peak, Phase, Plate, Primary, Puncture, Rated, Reactance, Recovery, Residual, Resistance, Restriking, Running, Secondary, Sparking, Spark-Over, Star, Symmetrical, Terminal, Thermal Agitation, Transient, Transverse,

True-Arc, and **Virtual.** See **ACTIVE VOLTAGE**, **ANODE VOLTAGE**, etc.

Voltage Amplification Factor. See **AMPLIFICATION FACTOR**.

Voltage Between Lines. The voltage between two mains in a d.c. or single-phase system or from main to main across one phase of a polyphase system but not between one phase and neutral.

Voltage Between Phases. See **VOLTAGE BETWEEN LINES**.

Voltage Circuit. The circuit in a meter, etc., carrying a current proportional to the voltage and connected, sometimes in series with a resistor directly across the mains.

Voltage Coefficient. The coefficient, generally known as *K*, by which the speed in revolutions per second, the number of armature conductors in series, and the flux in *Volt Lines* must be multiplied to obtain the e.m.f. of a dynamo.

Voltage Drop. The portion of the total voltage of a circuit "lost" or used up in overcoming the effects of resistance or impedance in any part thereof, or in any apparatus therein, usually expressed as a percentage of the voltage of the circuit.

Voltage Multiplier. A series resistance which enables a voltmeter to be used for higher ranges than that for which it can be used alone.

Voltage Multiplier, Electrostatic. See **ELECTROSTATIC VOLTAGE MULTIPLIER**.

Voltage of the System. See **VOLTAGE BETWEEN LINES**.

Voltage Ratio. See **RATIO OF TRANSFORMATION**.

Voltage Regulator. An apparatus, such as a *Shunt Rheostat*, for regulating the voltage of a circuit.

Voltage Regulator: Automatic, Induction, Magneto, and Switch Type. See **AUTOMATIC VOLTAGE REGULATOR**, **INDUCTION REGULATOR**, etc.

Voltage to Neutral. The voltage between one main and a neutral point in a star-connected system. Also called *Star Voltage* or *Y* voltage.

Voltage Transformer. A small well-insulated transformer used to

- couple a voltmeter, or other instrument requiring a current proportional to the voltage to a high voltage a.c. circuit by stepping down the voltage to a safe and convenient value to be brought to the instrument itself.
- Voltage Transformer Capacitor.** See CAPACITOR VOLTAGE TRANSFORMER.
- Voltaic Battery.** A battery composed of more than one *Voltaic Cell*.
- Voltaic Cell.** An old-fashioned name for an ordinary *Primary Cell*. Sometimes, however, held to comprise secondary cells also.
- Voltaic Current.** A current produced by an e.m.f., due to chemical action.
- Voltaic Electricity.** Manifestations of electricity in the form of electric currents. Cf. STATICAL ELECTRICITY.
- Voltaic Pile.** A source of e.m.f. consisting of a pile of pairs of discs of dissimilar metals, with a moistened pad between those composing each pair, thus forming a number of elementary cells in series; produced by Volta in 1796. Cf. DRY PILE.
- Voltaic Trough.** An early form of multi-cell zinc-copper single fluid battery due to Volta.
- Voltameter.** An instrument for measuring a current by the amount of a substance electrolysed by it in a given time. See ELECTROLYSIS.
- Voltameter : Copper, Gas, and Silver.** See COPPER VOLTAMETER, GAS VOLTAMETER, etc.
- Volt-Ampere-hour Meter.** A meter integrating volt-amperes.
- Volt-Ampere Meter.** An instrument for indicating volt-amperes irrespective of power-factor.
- Volt-Amperes (VA).** The product of the voltage and current in a circuit; otherwise known, in the case of alternating currents, as *Apparent Power*. See also KILOVOLT-AMPERES.
- Volt-Box.** See POTENTIAL DIVIDER.
- Volt-Gauge.** A simple form of *Voltmeter*.
- Volt-Line.** A unit of magnetic flux, sometimes used for convenience in dynamo design, and equal to 10^8 C.G.S. Lines or *Maxwells*.
- Voltmeter.** An instrument for measuring voltage directly by the reading of a pointer on a scale.
- Voltmeter :** Cardew, Compensated, Crest, Electrostatic, Ellipsoid, Feeder, Generating Electrostatic, Moulin, Moving Dielectric, Multicellular, Peak, Pilot, Reflex, Rotary, Sphere-Gap, Synchronising, Thermionic, and Thermo-. See CARDEW VOLT-METER, COMPENSATED VOLT-METER, etc. (For other types of Voltmeter see references under INSTRUMENT.)
- Volts Lost.** See VOLTAGE DROP.
- Volume Control.** Adjustment by varying retroaction, grid bias, etc., by a wireless receiver to control the loudness of the reproduction.
- Volume Control.** Automatic, Negative Automatic, and Tone Compensated. See AUTOMATIC VOLUME CONTROL, NEGATIVE AUTOMATIC VOLUME CONTROL, etc.
- Volume Expansion.** An arrangement similar to *Negative Automatic Volume Control* employed in sound-film production to extend the volume range and to reduce the proportion of background noise.
- Volume Resistivity.** Resistivity defined as resistance per unit length of unit area at a given temperature, i.e. *Specific Resistance* as usually understood. Symbol: ρ . Cf. MASS RESISTIVITY.
- Voss Machine.** See TOEPLER-HOLTZ MACHINE.
- "V" Rings.** See METAL AND MICA "V" RINGS.
- "V" Type Commutator.** A commutator in which the segments are made with dove-tailed projections by which they are held by the end rings.
- "V" Type Contacts.** Switch contact composed of several blades with bevelled edges bearing in grooves in the solid fixed contacts under spring pressure.
- Vulcanised Bitumen Cable.** See BITUMEN CABLE.

W.]

W. Abbreviation for *Watt*.

Walker Phase Advancer. A *Phase Advancer* of the *Expedor* type, consisting of a generator with a three-phase star-connected armature with a commutator and three field poles. Each of the three brushes is in series with one field coil, the other end of which is connected to one of the motor *slip* rings and the armature is driven directly by the main motor.

Wall Entrance Insulator. An arrangement for permitting of the passage of a bare high tension wire through a wall, e.g. a tube let into a wall, closed at one end by a glass disc, with a hole just sufficiently large to allow the wire to pass through. The tube is set on the slant for drainage purposes, and the wire is supported on ordinary insulators on each side of the wall.

Wall Plug. An appliance for connecting flexible leads to a wall socket when desired, consisting of suitable projecting pins or other contacts in an insulating holder, with provision for attachment of the conductors in the flexible cable. See *CONCENTRIC PLUG*, *TWO-PIN PLUG*, *THREE-PIN PLUG*, etc.

Wall Socket. See *SOCKET*.

Wander Plug. A plug on a flexible cord for making connections to any one of several sockets such as those forming tapings on dry batteries for the anode circuits of thermionic valves.

Wandering. Change in apparent direction of received wireless signals irrespective of the adjustment of the transmitter or receiver.

Ward-Leonard Control System. The control of the speed of a shunt wound direct current motor by the application of a variable voltage obtained from a motor-generator by shunt regulation. Used on large motors such as those of winding engines and rolling mills, where

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it is worth while to put down a separate motor-generator for each motor unit, and those where extreme speed variation is required, as in large rotary printing presses, See also *IGNER SYSTEM*.

Warming Plate (Electric). An electrically heated plate giving a temperature sufficient to keep food in dishes standing on it hot, but not to boil water. Cf. *BOILING PLATE*.

Washing Machine (Electric). A domestic washing machine driven by an electric motor.

Watch(es) : Demagnetisation of, Non-Magnetic, and Magnetised. See *DEMAGNETISATION OF WATCHES*, *NON-MAGNETIC WATCH*, etc.

Watch Receiver. A compact watch shaped *Telephone Receiver*.

Water-Column Arrestor. A *Lightning* or *Surge Arrestor* in which the live conductors are connected to earth by a running column of water breaking into a fine spray, or drops, having the equivalent of a multigap path.

Water-Cooled Motor, etc. A motor, etc., kept cool by circulation of water through special channels.

Water-Cooled Resistor. A resistor kept cool by circulation of water.

Water-Cooled Transformer. A transformer cooled by water circulating in coils of pipe inside the oil tank. Cf. *OIL-COOLED TRANSFORMER*.

Water-Cooled Valve. A large *Thermionic Valve* with water-cooled *Anode*.

Water Heater (Electric). A vessel for heating water electrically usually with heating elements in the base or walls of the apparatus. See also *IMMERSION HEATER*, *ELECTRODE BOILER* and *WATER-JET BOILER*.

Water-Jet Arrestor. An arrestor similar to a *Water Column Arrestor*, but in which the water is directed in a jet upward on to plates connected to the lines.

Water-Jet Boiler. An electric boiler in which the current flows through jets of water maintained by a circulating pump from earthed nozzles falling on to insulated electrodes and running down to an earthed perforated plate.

Water-Pail Forge. A method of heating metals for forging, etc., by connecting the metal to one pole of the circuit and dipping it in a solution in a wooden bucket connected to the other pole.

Water-Power Station. See HYDRO-ELECTRIC POWER STATION.

Waterproof Servicing. See SERVING.

Water-Tester, Dionic or Electrolytic. See DIONIC WATER TESTER.

Watertight Gland. A stuffing box arrangement to prevent entry of water where a cable enters a junction box.

Watertight Fittings, Switchgear, Motor, etc. Fittings, etc., enclosed in a casing protected against entry of water after prolonged immersion, usually of cast iron, with glass windows where necessary, and packed joints tightened by glands for the entry of cables, or screwed joints to pipes which enclose the cables.

Watt (W.). The practical unit of electric power (equal to 10^7 ergs per second, 1 joule per second or 1/746 h.p.). The power in a circuit in watts is equal to the number of volts multiplied by the number of amperes and, in the case of alternating current, by the power factor. See INTERNATIONAL WATT.

Wattful Current. See ACTIVE CURRENT.

Watt-Hour (Wh.). The practical unit of electrical energy, equal to 3600 joules, being that expended by 1 watt, flowing for 1 hour. See also KILOWATT-HOUR.

Watt-Hour Efficiency (of an Accumulator). The ratio of the energy obtainable during discharge to that put in during charging. Cf. AMPERE-HOUR EFFICIENCY.

Watt-Hour Meter. An integrating meter measuring energy in watt-hours or kilowatt-hours. Cf. AMPERE-HOUR METER.

Wattless Component, Current, Power,

Volt-amperes, etc. See REACTIVE CURRENT, etc.

Wattman. An expression sometimes used (particularly in France) for the driver of an electric train or train.

Wattmeter. An instrument containing one circuit in series with the current and another connected across the voltage, which react on one another in such a way that a deflection is obtained from which the power in the circuit in *Watts* can be read directly. See DYNAMOMETER TYPE INSTRUMENTS, etc.

Wattmeter: Compensated, Dynamometer Type, Electrostatic, Hot-Wire, Idle Current, Induction, Integrating and Thermionic. See COMPENSATED WATTMETER, DYNAMOMETER TYPE WATTMETER, etc.

Wattmeter Method (of Magnetic Testing). The testing of iron or steel by measuring the watts expended in a coil magnetising a sample with alternating current, directly by means of a *Wattmeter*. This will give the combined eddy current and hysteresis loss, but the former may be separated out by taking observations at several different frequencies. See ERSTEIN HYSTERESIS TESTER.

Watts: Apparent and True. See TRUE WATTS and APPARENT WATTS.

Wave (Electric). (1) A regular undulatory electromagnetic disturbance radiated from conductors in which electrical oscillations are taking place. Propagated through space at the same speed as light (3×10^{10} cm., or 186,000 miles per second), and essentially of the same nature but of greater wave length. The electric waves employed in wireless telegraphy, etc., range up to several thousand metres in length. Electric waves can also be propagated along conductors as well as across a dielectric. See RADIATION, PROPAGATION, etc. (2) The term "wave" is also employed to express the periodic variation of an alternating current. See WAVE FORM, SINE WAVE, etc.

Wave(s): Abnormally Polarised, Carrier, Continuous, Damped, Distorted, Electron, Ether, Fundamental,

Hertz, Interrupted Continuous, Long, Marking, Medium, Modulated Keyed Continuous, Normally Polarised, Polarised, Short, Side, Sine, Sine-shaped, Sinoidal, Sinusoidal, Spacing, Speech-Modulated Continuous, Standing, Stationary, Super-Audio-Frequency Modulated, Travelling, Type A, Type A1, Type A2, Type A3, Type A4, Type B, Ultra-Short, Undamped, and Unmodulated. Keyed Continuous. See ABNORMALLY POLARISED WAVES, CARRIER WAVE, etc.

Wave Aerial. An aerial, usually supported only a few feet from the ground, of a length equal to a multiple of the wave length to be received, in which wave reflection from the ends is prevented by resistances; giving high efficiency of reception and considerable directional effect without being unduly susceptible to atmospherics. (Also called BEVERAGE AERIAL.)

Wave Band. Waves of any wavelength between certain limits, e.g. the range of wavelengths set apart for broadcasting services.

Wave Changer. A switching arrangement enabling connections to be altered rapidly in a wireless transmitting apparatus to cause waves of a different wave length to be transmitted.

Wave Detector. See DETECTOR.

Wave Distortion. See DISTORTION.

Wave Filter. See FREQUENCY FILTER.

Wave Form. The actual shape of the curve representing the wave of an alternating current, etc.

Wave Form: Flat Topped, Peaked, and Sine. See FLAT TOPPED WAVE FORM, PEAKED WAVE FORM, etc.

Wave Front. The advance side of a current wave, i.e. the portion where the current is increasing. A term used principally with reference to the propagation of the start of a heavy current or surge, the effect of which largely depends on the "steepness" of the wave front, i.e. the rate of increase of the current. See also POTENTIAL FRONT.

Wavelength. The distance at any moment between successive zero

points or successive maxima of electric waves that are being transmitted; obtained by dividing the *Velocity of Propagation* by the *Frequency*. The wavelengths in common use in wireless telegraphy, etc., range from a few cm. to thousands of metres.

Wavelength: Fundamental, Natural, and Unloaded. See FUNDAMENTAL WAVELENGTH, NATURAL WAVELENGTH, etc.

Wavelength Constant. A property of a telephone line, etc., expressed by the formula:

$$\sqrt{\frac{L}{R}} \left\{ \sqrt{(R^2 + p^2 L^2)(S^2 + p^2 C^2)} - (SR - p^2 LC) \right\}$$

where R = resistance per mile, $p = 2\pi n$ (n = frequency), L = inductance per mile, C = capacitance per mile (in farads), and S = dielectric conductivity in mhos per mile, equivalent to the change of phase in radians per unit length. Cf. ATTENUATION CONSTANT and PROPAGATION CONSTANT.

Wave Lens (Electric). An appliance similar in its action to an optical lens, for concentrating electric waves, consisting of a special shaped grating.

Wave Meter. An instrument for measuring the wave length of electric waves by adjusting the inductance and capacitance (or both) of an oscillating circuit until the maximum degree of resonance is obtained. See CYMOMETER.

Wave Meter: Absorption, Buzzer, and Heterodyne. See ABSORPTION WAVE METER, BUZZER WAVE METER, etc.

Wave Shape. See WAVE FORM.

Wave Telephony. See CARRIER CURRENT TELEPHONY.

Wave Tilt. The forward inclination of the wave form of electric waves arriving along the ground, depending upon the electrical constants of the soil.

Wave Trap. An arrangement to enable one station to be rendered inaudible in a receiving set in order that a further station of fairly near wavelength can be heard; consisting either of a *Reflector Circuit* for

preventing oscillations of the unwanted frequency from passing, or an *Accepter Circuit* whereby they may be diverted.

Wave Train. A short series of waves, such as that proceeding from the disturbance set up by each spark in the *Spark System* of wireless telegraphy. See also **TONIC TRAIN**.

Wave Velocity. See **VELOCITY OF PROPAGATION**.

Wave Winding. A class of armature winding in which the winding does not overlap its previous course in loops, but follows in a wave-like course, with the *Winding Pitch* always positive; sometimes called a *Two-Circuit Winding*, because it provides only two circuits whatever the number of poles. Only two sets of brushes are required for any number of poles. Cf. **LAP WINDING**.

Wax, Cable. See **CABLE WAX**.

Wax-Operated Switch. A small sized circuit-breaker released by melting of wax in contact with a heated conductor on overload.

Ways. (1) The channels through multiple cable ducts. (2) Alternative current paths provided by a multiway switch.

Weak Coupling. See **LOOSE COUPLING**.

Weak Current Engineering. See **LIGHT CURRENT ENGINEERING**.

Wearing Depth of Commutator. The reduction of radius due to wear permissible on a commutator before the segments must be renewed.

Weatherproof Fittings, Motor, Switch-gear, etc. Apparatus protected from ingress of rain and generally suitable for outdoor use, but not necessarily fully enclosed so as to be *Watertight*.

Webb Furnace. A form of *Direct Arc Furnace* for steel manufacture.

Weber. A name proposed at the Paris Congress in 1889 for a practical unit of magnetic flux equal to 10^8 C.G.S. units, but adopted in America in 1894 for the C.G.S. unit itself (named after W. E. Weber, 1804-1891). This was, however, re-named the "Maxwell" by the Paris Congress of 1900. (The term had been pre-

viously used as the unit of current but was replaced by the ampere in 1881, and earlier still as the unit of quantity now called the coulomb.) It is now agreed that the term weber be used as the name of a practical unit of flux equal to 10^8 Maxwells which had been provisionally called the pramaxwell.

Weber Photometer. A portable *Photometer* in which the brightness of a diffusing screen in a tube directed towards the light source is compared by means of a prism with that of another similar screen, the distance of which from a standard lamp can be varied.

Weber's Electrodynamometer. An early galvanometer on the *Dynamometer* principle, with a fixed current coil within which is suspended a small moving coil by a bifilar suspension. Both coils are in series and the current is proportional to the square of the deflection.

Weber's Theory of Magnetism. An early form of the theory of magnetisation, according to which each molecule of iron is an independent permanent magnet constrained in some way by friction with its neighbours. Cf. **EWING'S THEORY**.

Weber's Unit of Resistance. A proposed unit of resistance based on the millimetre instead of the centimetre in the C.G.S. electro-magnetic system, and therefore equal to 10^{-10} ohms.

Wedge, Slot. See **SLOT WEDGE**.

Wedge Contacts. Contacts for oil circuit-breakers, etc., consisting of pairs of fingers between which are forced the wedge-shaped contacts on the moving contact bar.

Wedge Photometer. A class of photometer in which the light falling on two inclined sides of a wedge visible from the same point is compared. See **RITCHIE PHOTOMETER**.

Wehnelt Interrupter. An *Electrolytic Interrupter* in which one electrode consists of a plate of lead of considerable size and the other of a very fine platinum wire, in an electrolyte of dilute sulphuric acid. Cf. **SIMON and CALDWELL INTERRUPTERS**.

Weight Coefficient. The ratio of the weight of a motor to its output at a standard speed.

Weiss Magneton. See MAGNETON.

Welded Rail Joint. A joint in a tramway rail, etc., made *in situ* by welding the ends of the rails together. Electrically welded joints are made by passing a current of several thousand amperes, at a very low voltage, from a portable motor generator, through the joint while the joint is pressed together.

Welding (Electric). Welding together of two metal parts which have been brought up to the necessary temperature by passing a heavy current through them, or by the heat developed by an electric arc; sometimes, in the latter case, with the addition of fused metal from a rod forming one of the electrodes of the arc.

Welding: Arc, Atomic Hydrogen, Automatic Arc, Butt, Constant Current, Constant Power, Constant Voltage, Cyc-Arc, Flash, Metallic Arc, Quasi-Arc, Resistance, Resistance Percussive, Steam, Spot, and Variable Voltage. See ARC WELDING, ATOMIC HYDROGEN, WELDING, etc.

Welding Arc Voltage. The sum of the *True Arc Voltage* and the voltage drop in the electrode.

Welding Generator. A d.c. generator capable of giving a heavy current at a low voltage for welding purposes, usually with specially arranged differential excitation to give automatic regulation for constant current, constant power, or constant voltage.

Welding Transformer. A transformer with a heavy secondary winding of a few turns for producing a powerful alternating current at a low voltage for welding purposes.

Welding Unit. A term sometimes used for equipment such as a welding generator or welding transformer for the supply of current to one or more welding arcs.

Western Electric Automatic Telephone System. A system employing power-driven rotary multiple contact switches, characterised by the fact that dialling impulses are

stored up in an apparatus called a Register, which, in conjunction with other apparatus, proceeds to operate the selectors which make connection with the line required.

Weston Normal Cell. A standard *Cadmium Cell*, constructed according to a certain specification, and having an e.m.f. of 1.01830 *International Volt* at 20° C.

Weston Portable Cell. A portable form of the *Weston Normal Cell* with a slightly different strength of electrolyte but substantially the same E.M.F.

Weston Standard Cell. See WESTON NORMAL CELL.

Wet Battery. A collection of *Wet Cells*.

Wet Cell. A *Primary Cell* with a liquid electrolyte. Cf. DRY CELL.

Wet Spark-Over Test. A *Spark-Over Test* of an insulator made under artificial rain.

Wh. Abbreviation for *Watt-hour*.

Wheatstone's A.B.C. Telegraph. See A.B.C. TELEGRAPH.

Wheatstone's Automatic Telegraph. See AUTOMATIC TRANSMISSION.

Wheatstone's Bridge. An apparatus for measuring resistances in which the current from a battery divides into two parallel paths, each divided into two portions or "arms," which are adjusted so that there is no difference of potential between the dividing points on both sides, as shown by the absence of deflection of a galvanometer placed across them. The ratio of the resistances of the two pairs of arms is then the same, so that if the resistance of three of the arms is known, that of the fourth can be determined. See SLIDE WIRE BRIDGE, POST OFFICE BRIDGE, etc.

Wheatstone's Rheostat. An early form of variable resistance in which the resistance wire was wound on the outside of a cylinder arranged to be rotated to bring any point along the wire in contact with a fixed contact.

Wheel: Dimmer, Magnet, Phonic, Tone, and Trolley. See DIMMER WHEEL, MAGNET WHEEL, etc.

Wheelbarrow Suspension. See YOKE SUSPENSION.

Whittaker Protective System. A system of protection employing cables with a sheath to each phase. The tripping circuits are connected from core to sheath, and come into action when a difference of potential occurs between a core and its sheath.

Whole Coiled Winding. An alternator armature winding with one coil per pole subtending the whole pole. Cf. **HALF-COILED WINDING**.

Wren Bridge. An a.c. bridge method of measuring dielectric losses in which the capacitance to be tested and a standard condenser form two arms, and variable resistances the other two.

Wild-Barfield Furnace. A *Resistance Furnace* with wire heating elements for tool hardening and other heat treatment.

Wilson Closed Chamber. A vessel containing supersaturated water vapour, which renders the paths of atomic particles visible by the condensation along their tracks.

Wilson High Tension Generator. An apparatus for producing high potentials consisting of a motor-driven interrupter and two transformers, one of which, known as a buffer transformer, has a resonating secondary arranged to reinforce the impulses in one direction only by adjustment of the relative times of make and break.

Wimshurst Machine. The most widely used type of *Influence Machine*, consisting in its simplest form of two discs of insulating material revolving in opposite directions, each carrying a number of equal sectors forming combined *Inductors* and *Carriers*, two collectors and two pairs of brushes. Cf. **BONETTI, HOLTZ, TOEPFLER-HOLTZ and WÖRMELSDORF MACHINES**.

Wind (Electric). See **IONIC WIND**.

Wind-Driven Generator. (1) A generator driven through suitable gearing by a windmill, usually with a special system of excitation enabling it to give a practically constant voltage over a considerable range of speed variation, and used in parallel with an accumulator battery as in train and car lighting

systems. (2) A generator on aircraft to supply current for wireless telephony or other purposes, direct driven by an air-screw when travelling through the air.

Windage Loss. The energy loss in a machine due to air resistance.

Winder (Electric). A main shaft winding plant in a mine, driven electrically. In the larger modern examples the winding drum is driven by one or more motors coupled or geared to it, either of the direct current type supplied with current at a variable voltage from a flywheel motor-generator (see **WARD-LEONARD, LIGNER, and TURBO-ELECTRIC SYSTEMS**), or of the three-phase induction type, with special provision for running at variable speed with or without flywheel power equalisation. The control system is usually interlocked with the depth indicator and the compressed air or other brakes on the winding drum, so that the drum is held on a failure of current, and automatically slowed down and stopped at the right point, even if the driver should fail to move the control lever in time.

Winding. A general term employed to characterise the insulated system of conductors equivalent to one or many turns surrounding the magnetic circuit of dynamo electric machinery or any electromagnetic apparatus, or in any way arranged to produce or be acted on by a magnetic flux. A "winding" may be composed of any number of more or less separate *Coils*, each of which may consist of any number of "turns" wound in one or more "layers," and, again, each coil may be divided up into Sections.

Winding: Armature. Auxiliary, Banked, Bar, Barrel, Basket, Bifilar, Cable, and Bar, Chain, Chord, Closed-Coil, Commutating, Compensating, Compound, Concentrated, Concentric, Continuous, Counter-Compound, Cumulative Compound, Cylindrical, Decomposing, Déri, Diametral, Differential, Differential Compound, Disc, Distributed, Divided, Double-Layer, Drop-in, Drum, Duplex, Edge, Exciting, Field, Former, Fractional Pitch, Frog

Leg, Full Pitch, Hair-Pin, Half-Coiled, Hand, Hemitropic, Imbricated, Lap, Lattice, Leakage, Left Handed, Long Chord, Long Shunt, Magnet, Multicircuit, Multiple, Multiplex, Mush, Open, Circuit, Open Coil, Pin, Polyphase, Pressure, Primary, Re-entrant, Reverse Compound, Right-Handed, Ring, Sayers, Secondary, Semi-Distributed, Series, Series-Parallel, Short Chord, Short Shunt, Shunt, Simplex, Single-Layer, Single-Phase, Singly Re-entrant, Skew-Coil, Spiral, Spool, Starting, Step, Teaser, Tertiary, Threaded-in, Three-Phase, Three-Range, Three-Tier, Transposed, Triplex, Tunnel, Twisted, Two-Circuit, Two-Phase, Two-Range, Two-Tier, Wave, and Whole-Coiled. See ARMATURE WINDING, AUXILIARY WINDING, etc.

Winding (Electric). See WINDER.

Winding Coefficient. See WINDING FACTOR.

Winding Diagram. The scheme of an armature winding reduced to diagrammatic form to show clearly the course of the circuits without any attempt at correct scale or exact relative positions.

Winding Factor. A factor introduced into calculations of the e.m.f. given by an armature winding to allow for the different position of parts of the same coil, equal to the ratio of the arc to the chord subtended by the coil, sometimes called **BREADTH COEFFICIENT**. Another definition is the ratio of the effective e.m.f. of a winding distributed among several slots per pole per phase to that of a similar symmetrical winding with all the coils in one slot per pole per phase.

Winding Gear and Winding Plant. See WINDER (Electric).

Winding Pitch. The distance apart, usually reckoned in slots, of an armature conductor or coil and the one to which it is connected. See BACK PITCH and FRONT PITCH.

Winding Space. The section available in a slot, or in the apertures of a transformer core, etc., for the reception of the winding and its insulation. See SPACE FACTOR.

Windmill (Electric). An old-fash-

ioned apparatus producing rotation by the reaction of *Ionic Wind* from bent back sharp points on the arms of a pivoted cross.

Wing. A term sometimes used for the *Plate* or *Anode* of a *Thermionic Valve*.

Winter-Eichberg Motor. A variety of single-phase *Compensated Repulsion Motor* used for electric traction purposes; more correctly known as *Latour-Winter-Eichberg Motor*.

Wipe Contact. A contact between two surfaces which slide upon one another during the whole or part of the time that they are in contact.

Wipe-Out. A term sometimes used in wireless to describe temporary lapse of detector sensibility due to an excessive negative charge on the grid of a detector valve, due to an exceptionally strong signal or atmospheric, which takes an appreciable time to leak away.

Wipe-Out Area. That portion of the service area of a broadcasting station where the signal strength is too great to allow of the station being tuned out to hear other stations without special arrangements, i.e. where the field strength is over 30 millivolts per metre.

Wipe Spark. See BREAK SPARK.

Wiper (in Automatic Telephony). The moving arm in a *Selector* which moves over the *Banks* of fixed contacts.

Wiping Gland. A projection at the end of a cable box whereby a plumber's wiped joint can be made with the lead covering of a cable to ensure watertightness and conductive continuity of the sheathing.

Wire(s) : "A," Acetate, Active, "B," Bank, Bimetallic, Binding, Braided, Catenary, Code, Contact, Cotton-Covered, Earth, Enamel-Insulated, Eureka, Figure-Eight, Fish, Fourth, Fuse, Grooved, Guard, Guy, Holding, Idle, India Rubber, Insulated, Jumper, Leading-in, Lecher, Litzendraht, Magnet, Messenger, Middle, Neutral, Order, Overhead, "P," Pilot, Pressure, Pull-off, "R," Release, Resistance, Ring, "S," Screening, Silk-covered, Slide, Span, Suspension, "T," Telegraph,

Testing, Third, Tip, Tracker, Trolley, and Wollaston. See "A" WIRE, ACETATE WIRE, etc.

Wire Broadcasting. A broadcasting service in which a programme is supplied to subscribers by audio-frequency currents or modulated carrier frequency currents over permanent wire circuits. See also REDIFFUSION.

Wire Broadcasting, Audio-frequency and Carrier Frequency. See AUDIO-FREQUENCY WIRE BROADCASTING and CARRIER FREQUENCY WIRE BROADCASTING.

Wire Gauge : B. & S., Birmingham, British Standard, Brown & Sharpe, French, Legal Standard, Standard, and Stubs. See B. & S. WIRE GAUGE, BIRMINGHAM WIRE GAUGE, etc.

Wire Lamp. A name at one time used for an incandescent lamp with a wire-drawn *Filament*, to distinguish it from one with the older type of *Squirted Filament*.

Wired Wireless. A name sometimes used for *Carrier Current Telephony* and telegraphy, owing to the high frequency oscillatory currents employed being regarded as electric waves guided along wires.

"Wireless." A term that is popularly used for the whole subject of transmission of messages, etc., by means of electric waves through space without any connecting wires, irrespective of the fact that wires are commonly used to form the aeriads at both ends. The term, although open to criticism, is employed in this work in preference to "Radio" on account of its wider acceptance in Great Britain, where it is employed in the official designation of a section of the Institution of Electrical Engineers.

Wireless Beacon. A wireless transmitting station sending out characteristic signals for use in conjunction with direction-finding apparatus or otherwise to assist in aerial or marine navigation.

Wireless Beacon, Rotating. See ROTATING WIRELESS BEACON.

Wireless Beam. Electric waves, usually of short wavelength, con-

centrated into a nearly parallel beam of suitable reflectors. See BEAM SYSTEM OF WIRELESS TELEGRAPHY.

Wireless Call Bell. See AUTOMATIC WIRELESS CALL DEVICE.

Wireless Call Signal. A special signal, such as an abnormally long dash or a series of specially-timed dots, which actuates an *Automatic Wireless Call Device*.

Wireless Compass. A simple form of *Wireless Direction Finder* for marine purposes.

Wireless Direction Finder. An apparatus for determining the direction from which electric waves are proceeding, e.g. the *Bellini* and *Tosi System*, in which two aeriads are used in planes at right angles to each other and the relative strength of the signals picked up compared by an instrument called a *Radiogoniometer*. In another form of direction finder the whole aerial is of a compact form, and is made to rotate until the maximum strength of signal is obtained. By combining two direction finders at the ends of a known base line, a wireless range finder can be made, as in the *Kolster* apparatus. Such apparatus is liable to certain causes of error. See CALIBRATION ERROR, LOOP TUNING ERROR, LACK OF SYMMETRY ERROR, PLAIN TUNING ERROR, ELECTROSTATIC ERROR, COUPLING ERROR, ROTATING WIRELESS BEACON, AUTOMATIC DIRECTION FINDER, and ROBINSON'S DIRECTION FINDER.

Wireless Echo. The repetition of a wireless signal by waves which have travelled by a longer path than those producing the first signal, such as round the world, or in the case of short wave, are reflected back by conducting emanation from the sun deflected by the earth's magnetic field.

Wireless Fix. A determination of the actual position of a station, ship, or aircraft by means of simultaneous cross bearings obtained from two *Wireless Direction Finders* a known distance apart; employed in tracing the movements of enemy ships and aircraft.

Wireless Link. The use, in broadcasting, of a portable or other wireless transmitter to convey the effect of the modulations of a distant microphone to a special receiver in the broadcasting station, or connected by line to it in cases where direct connection by line is not practicable.

Wireless Receiver. A receiving equipment for wireless telegraphy or wireless telephony.

Wireless Station. An installation for sending or receiving signals (or both) by wireless telegraphy or wireless telephony.

Wireless Telegraphy. The transmission and reception of code signals by intermittent electric waves (also called *Radiotelegraphy*, *Electric Wave Telegraphy*, *Space Telegraphy*, *Etheric Telegraphy*, etc.). Other means not requiring a connecting wire between the two stations, such as *Earth Conduction Telegraphy*, are not commonly included in the meaning of the term.

Wireless Telegraphy: Arc System, Beam System, De Forest System, Directional, Fessenden System, Lepel System, Lodge-Muirhead System, Marconi System, Poulsen System, Quenched Spark System, Spark System, and Telefunken System. See ABC SYSTEM OF WIRELESS TELEGRAPHY, BEAM SYSTEM OF WIRELESS TELEGRAPHY, etc.

Wireless Telephony. The transmission and reception of spoken words or other sounds by means of electric waves. In the usual systems of wireless telephony, *Continuous Waves* are employed of a much higher frequency than those of audible sounds, and the amplitude of those is modulated by the connection of a microphone to some part of the transmitting circuit, and the receiving equipment, generally similar to that employed for wireless telegraphy, is arranged so that the receiving telephone responds to the modulations of the waves and reproduces the original sounds.

Wireless Television. See TELEVISION.

Wire-Wound Armature. An arma-

ture wound with ordinary wire. Cf. BAR WOUND ARMATURE.

Wiring: Buried, Concentric, Conduit, Cleat, Distribution Board, Earthen, Earthen Concentric, Exposed, Flexible, Insulated, Interior, Side-Tone Reduction, Single Conductor, Surface, Tree, and Two-Conductor. See BURIED WIRING, CONCENTRIC WIRING, etc.

Wiring Point. Any point in an interior wiring installation where provision is made for connection to a branch circuit of a fitting with one or more lamps, a wall plug. Also called (particularly in U.S.A.) *Outlet*. See also SWITCH POINT.

Wollaston Wire. Very fine wire, made by coating fine platinum wire with silver, drawing it down further and dissolving off the silver.

Wolpyn Process. A process claimed to increase the yield of seeds by immersion in an electrolyte through which a current is passing, and subsequent drying before sowing.

Wommelsdorf Machine. A form of *Influence Machine*, with alternate fixed and moving plates and collectors in the form of steel wires dipping into grooves in the rims of the moving discs.

Wood Casing. See CASING.

Work. The work done by the energy of an electric current is measured in *Joules*. This unit is equivalent to the work done by one watt in one second. Symbol: *A*.

Working Flux. That portion of the total flux in a machine which interlinks the active conductors in both rotor and stator, or, in a transformer, both primary and secondary windings, i.e. not including the *Leakage Flux*.

Working Standard. A standard used for every day measurement and calibration; standardised by comparison with a *Secondary Standard*.

Wound Rotor. A Rotor of an *Induction Motor* wound with wire coils connected to *Slip-Rings* so that a resistance can be put into the rotor circuit at starting, or for running temporarily at reduced speed, and short circuited at full speed. Cf. SQUIRREL CAGE ROTOR.

Wreath Filament. A coiled filament

mounted in a horizontal ring of hooks in a supporting spider, and hanging loosely in festoons between the hooks, as in the larger gas-filled lamps (giving a reduction factor from 0·8 to 0·9).

Writing Telegraph System. A system of telegraphy in which the message is written down automatically in

characters resembling handwriting. See TELAUTOGRAPH.

Writing Telegraph, Pollak-Virag. See POLLAK-VIRAG WRITING TELEGRAPH.

Wurtz Arrester. The class of lightning arrester in which spark gaps of zinc or other *Non-Arcing Metal* are used.

X.]

["X"]

X. Symbol for *Reactance*.

"X" Ray Crystallography. The investigation of the structure of a crystal by the reflection or diffraction of "X" Rays by its facets.

"X" Ray Examination of Material.

(1) The examination of materials for hidden flaws, impurities, etc., by "X" Ray Photographs or by viewing with a fluorescent screen.

(2) Examination of the "X" Ray Spectrum of the material.

"X" Ray Photograph. A photographic record of the shadow of an object cast by "X" Rays; capable of revealing embedded articles and interior structure in a way not possible with ordinary light, owing to the different range of penetrative power of "X" Rays. (Also called *Radiograph*, *Radio-gram*, *Skiagraph*, *Skiagram*, and *Röntgenogram*.)

"X" Ray Spectrograph, Spectrometer, and Spectroscope. An apparatus for recording, measuring, and observing "X" Ray Spectra respectively.

"X" Ray Spectrum. A diagram showing what are the wavelengths of the component in an "X" Ray beam. See also CHARACTERISTIC "X" RAY SPECTRUM.

"X" Ray Transformer. A special type of transformer for giving the high voltages necessary for the working of "X" Ray Tubes.

"X" Ray Tube. A highly exhausted *Vacuum Tube* in which a stream of *Cathode Rays*, given off from a cathode (sometimes heated to facilitate emission of electrons) falls upon an *Anti-Cathode* or *Target* within the tube, causing it to give off "X" Rays of wavelengths the lower limit of which depends on the applied voltage. See HARD TUBE, SOFT TUBE, GAS TUBE, ELECTRON TUBE, METAL TUBE, OSMO-REGULATOR, MERCURY AIR VALVE REGULATOR, PILON REGULATOR, etc., and references below.

"X" Ray Tube: Coolidge, Gundelach, Jackson, Lillienfeld, Ray Protected and Shielded. See COOLIDGE TUBE, GUNDELACH TUBE, etc.

"X" Rays. Rays, also called, after their discoverer, W. K. von Röntgen (in 1895), *Röntgen Rays*, consisting of electric waves of much higher frequency than light (but not as high as that of *Gamma Rays*), produced when the velocities of rapidly moving electrons are altered, e.g. by the striking of *Cathode Rays* upon a solid substance. See "X" RAY TUBE. They possess the following characteristic properties: They are not deflected by electric or magnetic fields. They can penetrate solid substances which cannot be penetrated by ordinary light, and cause considerable photographic and other chemical effect. See "X" RAY PHOTOGRAPH. They cause electrons to be emitted from solid bodies upon which they fall. They are not reflected or refracted under ordinary conditions, but are diffracted if reflected by crystals. (See "X" RAY SPECTRUM.) They excite *Fluorescence* in certain substances, such as barium platinocyanide and they cause *Ionisation* of gases through which they pass. Their wave lengths range from 0.06 to about 1,000 Ångström units. See also ULTRA "X" RAYS.

"X" Rays: Characteristic, Fluorescent, Hard, Scattered, Secondary, Soft, and Ultra. See CHARACTERISTIC "X" RAYS, FLUORESCENT "X" RAYS, etc.

"X" Stopper. An arrangement for avoiding the interference of stray waves, *Atmospherics*, or "X's" in wireless telegraphy, by providing a conducting path to earth from a point which forms a node in the receiving aerial circuit, so that irregular oscillations are conducted to earth without interfering with the reception of those for which the receiving circuit is tuned.

"X's" see ATMOSPHERIC.

Y

Y.]

Y. Symbol for *Admittance*.

"Y" Connection. See STAR CONNECTION.

"Y"-Delta Starter. See STAR-DELTA STARTER

"Y" Voltage. See VOLTAGE TO NEUTRAL.

Yoke. A magnetic path of low reluctance connecting two parts of a magnetic circuit, e.g. the part connecting the two poles of a *Bipolar* machine, or the outside steel ring into which are fixed the inwardly projecting poles in a *Multipolar Machine*.

Yoke: Brush, Double Bar, and

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Laminated. See BRUSH YOKE, DOUBLE BAR YOKE, etc.

Yoke Suspension. Suspension of a traction motor in which about half the weight of the motor is spring borne from the end away from the axle, on a transverse bar mounted on springs on the truck, and the remainder is supported by the axle itself through bearings on it. Cf. RIGID SUSPENSION, and SIDE BAR SUSPENSION.

Yrneh (Henry spelt backwards). A name proposed for a practical unit of *Reluctance*, being $4\pi/10^9$ *Oersted*.

Z.]

Z. Symbol for *Impedance*.**Zamboni's Dry File.** See **DRY FILE**.**Zeeman Effect.** The multiplication of the spectrum lines of light sources when in a strong magnetic field.**Zero, False and Inferred.** See **FALSE ZERO** and **INFERRED ZERO**.**Zero Beat.** An expression used in wireless telephony, etc., for the state of affairs when a receiving circuit is oscillating at the exact frequency of the incoming waves so that no beat tone is produced, although other objectionable features of re-radiation and distortion may still be present; also called *Dead Space*.**Zero Method.** Any method of measurement in which adjustments are made until no current passes and therefore no deflection is produced in a galvanometer, etc., or in which no change in deflection is produced by some alteration of connections.**Zero-Point Anode.** An additional *Anode* in a *Grid Controlled Mercury Vapour Rectifier* connected to the neutral point, which modifies the wave-form in a way which permits of better regulation and increased output with better efficiency.**Zero Potential.** An expression often used for the potential of the earth which is taken as zero for convenience in comparison.**Zero Type Dynamometer.** A dynamometer in which electrical and

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mechanical forces are balanced so that the moving system is brought back to zero to take a reading, e.g. the *Siemens Dynamometer*.**Zerograph.** An early form of start-stop printing telegraph apparatus, designed by L. Kamm.**Zig-Zag Connection.** A modified star connection of polyphase circuits in which each branch contains portions of two consecutive phases.**Zig-Zag Leakage** (in *Induction Motors* etc.). *Magnetic Leakage* which travels in a zig-zag course across the air gap in induction motors, etc., on account of the short-circuiting effect of a rotor tooth when opposite a stator slot, sometimes used to include all other forms of magnetic leakage within the air gap, such as *Belt Leakage*.**Zinc-Lead Accumulator.** A type of accumulator in which a zinc negative electrode is used in conjunction with a lead peroxide positive of the ordinary type in an electrolyte of dilute sulphuric acid.**Zinc Vapour Lamp.** A *Discharge Lamp* with a certain amount of zinc vapour in the bulb having similar characteristics to a *Cadmium Vapour Lamp*.**Zirconium Oxide Lamp.** An incandescent lamp with zirconium oxide incorporated in the filament.**Zone, Commutating and Neutral.** See **COMMUTATING ZONE** and **NEUTRAL ZONE**.

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